TEXT GENERATION PROCESSES IN THE DEVELOPMENT OF WRITTEN COHESION: THE CONTRIBUTION OF SEMANTICS AND SYNTAX

by

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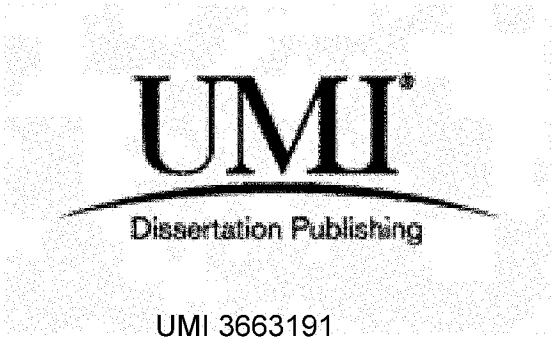

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ABSTRACT

The ability to write cohesive texts is a complex skill that engages multiple cognitive processes including language. However, there is a dearth of research examining the relationship between language skills and the emergence of cohesion. In this two part study, I examined the differential contributions that oral syntax and semantic skills make to fourth-grade children's ability to write cohesive texts. In the first experiment, regression analyses showed that assessed semantic skills accounted for approximately 15% of the variance associated with conjunction use, indicating that children with higher semantic abilities used fewer conjunctions in their writing. There was also a relationship between assessed syntax skills and the appearance of semantically related words in writing, such that children with stronger syntax skills tended to use fewer semantically related words. In the second experiment, children received either semantic, syntactic, or no language treatment over a period of four weeks. Children receiving semantic treatments showed increases in the number of semantically related words that appeared in their writing over the course of treatment. This change included a greater increase in the use of sophisticated lexical devices than the control group. Children receiving syntactic treatments changed the way they used conjunctions at midtreatment. More specifically, they showed a reduction in the use of simple conjunctions like *and, then,* and *so* following oral practice with more complex conjunction and sentence forms. All three groups showed improvements in cohesion as demonstrated by a decrease in the distance between ties; however the changes for those receiving language treatments were larger and occurred sooner than for those in the control condition. These changes mirror developmental trends that have been found in cross-sectional studies of cohesion development. Overall, this two part study shows that both

semantic and syntactic language processes and representations impact cohesion, and that the contributions of semantics and syntax to the way children write are different. Discussion of the findings includes the implications these results have for our understanding of the emergence of cohesion, and of text generation processes. Limitations and implications for practice and future research are also discussed.

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GLOSSARY

Adverbials: the use of adverbs or adverbial phrases to mark the temporal relationships between events within a text. Adverbials capture aspects of temporal conjunctive cohesion.

Adversatives: the use of conjunctions to indicate opposing or contrary relationships between events. Adversative conjunctions are one type of conjunctive cohesion.

Anaphor overlap: a variable produced by the web-based computer scoring system, Coh-Metrix. It refers to the proportion of sentences that contain a pronoun tie to the previous sentence. Anaphor overlap (ANA) captures one aspect of reference cohesion.

Associative processing: processing among verbal representations within the verbal system or among nonverbal representations within the nonverbal system.

Causal conjunctions: the use of conjunctions to indicate causal relationships between events within a text. Causal conjunctions are one type of conjunctive cohesion.

Cohesion: the unity of a piece of discourse (in this case written text) accomplished through the use of linguistic devices.

Collocation: a form of lexical cohesion in which semantically related words are present in the text. Words may have complimentary thematic relationships (e.g., *mom* and *dad*), or be converses of one another (e.g., *ask* and *answer*, *up* and *down*)

Conjunctions (conjunctive cohesion): the use of conjunctions to indicate the relationship between ideas, and therefore sentences, within a written text.

Coordinating conjunctions: the use of coordinating conjunctions to add information. In narrative texts, coordinating conjunctions typically capture both additive (e.g., *and*) and temporal (e.g., *then*) conjunctive cohesion.

Demonstratives: the use of demonstratives (e.g., *the*, *this*, and *that*) before a noun to refer to an element previously mentioned within the text. Demonstratives make up one type of referential cohesion.

Immediate ties: sentence adjacent cohesive devices. A tie is considered immediate if the reference or lexical device refers to a noun in the previous sentence. As well, all conjunctions are immediate ties.

Incidence of connectives: a variable produced by the web-based computer scoring system Coh-Metrix. It refers to the incidence of conjunctions per 1000 words. The incidence of connectives (CON) captures conjunctive cohesion.

Latent Semantic Analysis (LSA): a mathematical representation of the semantic relationships among words. The variable produced by the web-based computer scoring system, Coh-Metrix captures sentence adjacent lexical cohesion.

Lexical cohesion: The use of semantically related words to create unity across a text.

Mean distance: a measure of distance for cohesive ties. It is the overall mean of the distances for all mediated and remote reference and lexical ties. Smaller mean distances indicate tighter cohesion.

Mediated ties: a pronoun or noun that refers to a pronoun in the previous sentence.

Near synonym: a form of reiteration. Near synonyms are words that refer to a previously mentioned character, event, place, or item, but are not repetitions of the same word or true synonyms. Examples of near synonyms might include categorical subordinates

or superordinates, nicknames, or stylistic word choices. Near synonyms are one type of lexical cohesion.

Pronoun (pronominal) reference: the use of pronouns to refer to a previously mentioned noun. Pronouns make up one type of referential cohesion.

Reference (referential cohesion): The use of pronouns and demonstratives to refer back to a character, place, event, or item previously mentioned in the text.

Referential processing: processing between verbal and nonverbal representations. This type of processing gives rise to the meaning of language.

Repetition: a form of reiteration in which the same word is used repeatedly to refer to a character, event, place, or item. Repetition is one type of lexical cohesion.

Subordinating temporal conjunctions: the use of subordinating conjunctions used to mark temporal relationships between events in a text. Subordinating conjunctions capture aspects of temporal conjunctive cohesion.

Synonym: a form of reiteration in which a true synonym is used to refer to a previously mentioned character, event, place, or item. Synonym use is one type of lexical cohesion.

T-unit: a subordinating clause with any attached subordinating clauses.

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DEDICATION

I dedicate this work to the two most important people in my life, John and Nolan, who were both my rocks and my cheerleaders. Their unwavering support made this journey enjoyable.

CHAPTER 1

Text Generation Processes in the Development of Written Cohesion: The Contribution of Semantics and Syntax

Learning to write is an undeniably complex task engaging multiple skills and abilities. For example, children must learn the mechanical aspects of writing such as handwriting and spelling. Handwriting requires motor-perceptual and orthographic skills (Abbott & Berninger, 1993) and spelling requires phonological, orthographic, and morphological knowledge (Bourassa, Beaupre, & MacGregor, 2011; Bourassa & Treiman, 2001). In addition, developing writers also must be able to use punctuation effectively (Rubin, 1978; Singer, 1995), select appropriate vocabulary (Connelly, Dockrell, & Barnett, 2012), form grammatically correct sentences (Scott & Windsor, 2000), and construct coherent texts (McCutchen & Perfetti, 1982).

Given the range of skills required, it is clear that writing engages multiple underlying cognitive processes and representations. Of these processes and representations, McCutchen (2000) argued that a strong knowledge base (i.e. semantic knowledge) and fluent formulation of words and sentences have the greatest impact on the development of expertise in writing. In children, idea formation from a knowledge base and language formulation processes may be separate, such that young writers may be able to generate ideas but struggle to find the language to adequately express their thoughts (Berninger & Swanson, 1994). Therefore, to fully understand how writing develops, it is important to understand the language processes involved.

It has been argued that language processes such as lexical retrieval, syntactic formulation, and selection of linguistic content are shared by oral and written language

systems (McCutchen, 1996). Support for this argument comes mainly from demonstrations that skill in oral language is related to skill in writing (Berninger, 1996; Connelly et al., 2012; McCutchen, Covill, Hoyne, & Mildes, 1994; Roth 2000). In fact, it is widely accepted that development in oral and literate language skills have a reciprocal relationship (Berninger, 2000; Byrnes & Wasik, 2009; Perera, 1984) such that growth in one area is associated with improvements in the other. However, Shanahan (2006) argued that while reciprocal relationships exist, due to the later and longer development of writing, oral language is likely to have a greater effect on writing development than the reverse. Furthermore, Pugh et al. (2006) argued that writing is a derivative of oral language citing evidence that a deficit in oral language perception and production also impacts written language correlates.

Even though writing calls upon linguistic processes shared by the oral language system (McCutchen, 1996), oral language use and writing differ by the proximity of a communication partner, which has an impact on the way these linguistic processes are used. Whereas oral language use involves immediate feedback and a shared context with a conversational partner, with writing, the audience is removed. Therefore, to allow for effective communication between writer and reader, the language produced in a written text must stand alone; that is, the meaning of the message must be captured more wholly by the text due to the absence of a shared context or opportunity for ongoing elaboration, both of which help to establish shared meaning in oral communication. Consequently, the process of learning to write well involves moving from open conversational language forms to the closed language forms required by composition (Bereiter & Scardamalia, 1987; Perera, 1984, Rubin, 1978).

This developmental progression is marked by a number of observable changes in writing, one of which is the different kinds of connections that appear between sentences and among ideas within the written text (Sanders & Schilperoord, 2006; Sanders & van Wijk, 1996; van Wijk & Sanders, 1999). Van Wijk (1999) described this developmental progression for increased connectivity in writing as follows. Initially, beginning writers produce strings of unrelated sentences. As they develop in skill, their sequence of sentences begin to share an overriding topic. Then gradually, writers begin to produce texts that also contain connections between sentences, and eventually, begin to add structures that maintain coherence across the text. Finally, with expertise in writing comes the production of texts that are characterized by topic adherence, connections between sentences, and coherence across the text, along with stylistic choices.

Linguistic devices of cohesion play an integral role in establishing this increasing connectivity among ideas and sentences. Cohesive devices bind sentences together to form a unified text, contributing to both topic and overall coherence. Without cohesion, a written text would appear as a string of unconnected sentences (Halliday & Hasan, 1976).

Three types of cohesive devices, examples of which are presented in Table 1, are typically found in writing (Cameron, Lee, Webster, & Munro, 1995; Crowhurst, 1987). The definitions for these devices are based on the seminal work of Halliday and Hasan (1976). One type of device is *reference*. Referential cohesion involves the use of pronouns and demonstratives to refer to some previously mentioned information in the text. Local connectedness is signalled by the use of these reference ties, which link sentences anaphorically to what has already been written, and in some cases, cataphorically to alert the reader to what is coming up (Kuo, 1995). Reference devices establish local connections but

also support adherence to a global topic through repeated referral to specific information already stated in the text.

Another cohesive device used in writing is *conjunction*. Conjunctions include additive, temporal, causal, and adversative types. Conjunctive cohesion is used to explicitly show the relationship of new information to previously given information, thus corresponding with coherence across a text, as well as establishing local connections between sentences.

The last cohesive device commonly found in writing is *lexical* cohesion. One type of lexical cohesion, *lexical reiteration,* occurs when characters, places, or events are repeatedly mentioned (lexical reiteration) through word repetition, superordinates/subordinates, or synonyms or near synonyms. Another type of lexical cohesion, *collocation*, occurs when semantically related words appear throughout the text. Collocation devices include semantically related complements or converses. As topic coherence reflects the semantic unity of the information retrieved and recorded when writing (McCutchen & Perfetti, 1982), lexical reiteration and the presence of semantically related words clearly coincides with topic coherence.

With the developmental progression from beginning to skilled writing involving the production of texts with increasingly greater connectivity among ideas and sentences, it is not surprizing that we find changes in the way cohesive devices appear in the writing of individuals at different places along that progression (Crowhurst, 1987; Fitzgerald & Spiegel, 1986; McCutchen & Perfetti; 1982; Rentel, King, Pettegrew, & Pappas, 1983; Rutter & Raban, 1982; Yde & Spoelders, 1985). I will elaborate on these developmental changes in

Chapter 2. For now, the point to be made is that changes in cohesion reflect growth in writing development.

However, the question remains as to what cognitive developments lead to these cohesion changes in writing. As indicated previously, there is a relationship between oral and literate language abilities, such that oral language is thought to contribute to writing development. Similarly, evidence shows that the use of cohesive devices also is related to language abilities. For example, it has been demonstrated that individuals with histories of language impairment (Hedberg & Fink, 1996; Liles, 1985; Mortensen, Smith-Lock, & Nickels, 2009) and poor readers (Cox, Shanahan, & Sulzby, 1990; Cox, Shanahan, & Tinzmann, 1991) use cohesive devices differently in their writing. Despite evidence pointing to a relationship between language and cohesion, the specific nature of this connection remains unclear. More to the point, it is unknown whether cohesion is related to the semantic or syntactic aspects of language.

For instance, Halliday and Hasan (1976) saw cohesion as semantic, indicating that cohesion refers to the meaningful associations within a piece of writing that define it as a unified text. Cohesive markers are thought to help the reader make bridging inferences to create a coherent and meaningful mental representation of the text (Singer & Remillard, 2004). This relationship to meaningfulness adds weight to the argument that cohesion is a semantic construct. Additionally, it seems likely that a coherent semantic mental representation of the ideas to be communicated must be involved in the creation of cohesive writing. For instance, in order to achieve lexical cohesion, activation of semantically related images and words within the writer seems necessary.

Table 1

Examples of Cohesive Devices

Type	Subtype	Examples
Reference	Pronouns	Any pronoun
	Demonstratives	*the, that, this, those, these* before a noun
Conjunction	Additive	*and, also, in addition to, or,* etc.
	Temporal	
	Coordinating	*then, so,* etc.
	Subordinating	*when, before, after,* etc.
	Adverbials	*next, all of a sudden, one day, eventually,* etc.
	Causal	*because, therefore, consequently,* etc.
	Adversative	*but, although,* etc.
Lexical	Reiteration	
	Repetition	Repeated words like *dog-dog*
	Other reiteration	Super-ordinates or subordinates like *dog-animal*
		OR
		True synonyms or near-synonyms like *dog-mutt*
	Collocation	
	Complements	Commonly co-occurring words like *beach-sand*
	Converses	Converses or antonyms like *ask-answer* or *up-down*

Alternative to this semantic view, some researchers acknowledge that certain aspects of cohesion may be more related to the rules that govern the structural (syntactic) aspects of a language (Palmer, 1999; Xi 2010). Although more arguments for a semantic origin of cohesion can be found in the literature, it is difficult to determine if this imbalance results from a limited role for syntax, or an absence of research in the area. Despite the present lack of research evidence, some aspects of cohesion appear to be syntactic in nature. For example, the use of cohesive conjunctions requires the ability to formulate complex syntactic structures. The use of sentence initial adverbs and adverbial clauses to transition from one idea to another also requires syntactic knowledge. Similarly, appropriate use of demonstratives (e.g. 'the') and agreement between pronouns and referents involves grammatical knowledge.

Arguments for both semantic and syntactic views of cohesion appear viable. In fact, cohesion may be related to more than a single language domain. For example, in an earlier study of cohesion in the writing of school-aged children, we found that children's performance with the use of referential cohesion, conjunction, and lexical cohesion were unrelated to one another (Struthers, Lapadat, & MacMillan, 2013), suggesting that use of each type of cohesive device may be related to a different underlying linguistic skill or ability. This finding led to the question of whether levels of semantic and syntactic abilities make differential contributions to cohesion in writing.

The Problem

Text generation processes in children involve the formulation of language to express ideas in a written form. Included in this formulation process is the retrieval and use of cohesive devices, which contribute to the connectivity and coherence of writing. If

development in writing involves creating more coherent texts with increased local connections among sentences, then changes in the use of cohesive devices that mark these connections may act as an indicator of this progression. Furthermore, if written cohesion changes with advances in writing ability, and writing and cohesion use both are related to language development, then greater facility with one or another component process of language, that is semantics or syntax, should have a differential effect on the appearance of cohesion in developing writers.

However, how the component processes of language contribute to writing in general, and cohesion specifically, is still unclear. There are two complications interfering with the clarification of this issue. First, it is currently unsettled as to whether cohesion is primarily a semantic or grammatical/syntactic construct (Xi, 2010). Second, the differential relationship of semantic and syntactic development to writing has not been clearly established. Thus, the interest here is in examining the emergence of cohesive devices in the writing of children, and the underlying language components that contribute to their development.

The specification of the sources of and the processes by which coherence is achieved, as well as a description of how these sources and processes change cohesion over time is an important consideration for developmental models of writing processes (McCutchen & Perfetti, 1982). In this study, I will address these issues by examining how semantic and syntactic development impacts the use of cohesive devices in young writers.

CHAPTER 2

Literature Review

To examine the contributions of semantics and syntax to the development of cohesion in writing, I turn first to a review of the background literature. This review includes a brief account of the historical context for this research, and a description of the theoretical assumptions that guide the questions and approach used in this study. I review previous studies on the development of written cohesion, as they provide the starting point for this study. Additionally, I examine empirical evidence for the measures and methods used in this study. Finally, I explain the proposed contributions of this research.

The History of Writing Research: A Missing Link

Empirical research of writing processes did not really begin until the 1970s (Nystrand, 2006). Prior to that time, writing was viewed through a behavioural lens, with the focus on examining the texts of expert writers to determine what elements constituted good writing (Britton, Burgess, Martin, McLeod, & Rosen, 1975). The early 1970s saw the emergence of studies examining the strategic processes of writing (Emig, 1971; Hayes & Flower, 1980), based on the composing of experienced writers. However, children do not write like adults (Bereiter & Scardamalia, 1987; Berninger, 1996).

Bereiter and Scardamalia (1987) introduced the first model of composing that considered the development of writing in children. They described the composing of children as a sequential process of retrieving discourse and content knowledge from long term memory and scribing information in the sequence it is retrieved. This model, called *Knowledge Telling,* like its predecessors, focused on the strategic aspects of composition, and did little to explain the implicit processes involved in writing. Kellogg (1999) later

elaborated on the Knowledge Telling account of writing to include the role of working memory, but still did not address the linguistic processes and representations involved in composing.

It was not until researchers like Treiman and her many colleagues, who examined the linguistic processes underlying spelling development (Bourassa & Treiman, 2001; Treiman, Caesar, & Zurkowski, 1994), and the work of Berninger and her colleagues, who, in the 1990s, proposed new models of composing that applied to children, that attempts were made to account for the language processes involved in written composition. For example, Berninger and Swanson (1994) proposed that the process of translating ideas into writing involves two component subprocesses, namely *transcription* and *text generation*. Transcription includes the subskills of handwriting (or keyboarding) and spelling, and text generation involves the conversion of ideas into words, sentences, and discourse. Berninger (1996) conceptualized language on the basis of word, sentence, and paragraph levels rather than on the basis of semantics and syntax, thus this account of writing also falls short of defining the roles of semantic and syntactic contributions to text generation. In the absence of a writing model that specifies the role of semantics and syntax, we must turn to a more general model of linguistic processes and representations.

One theoretical account that describes language processes and representations is dual coding theory. According to this theory, cognitive information is coded both verbally and nonverbally within the sensory mode in which it is captured from the environment (Sadoski & Paivio, 2013). The appeal of this theory is three fold. First, dual coding theory is a connectionist account of cognition (Sadoski & Paivio, 2013). Unlike traditional models that describe cognition as the rule-governed manipulation of abstract symbols (Branquinho,

2001) and ignore the role of neurological states (de Zubicaray, 2006), connectionist frameworks explain cognition as nonsymbolic and closely related to the neurological states that underlie thought and behaviour (de Zubicaray, 2006). As such, connectionist views of cognition can be supported by advances in neuropsychological research (de Zubicaray, 2006). Connectionist models also have the advantage of explaining both performance (i.e. the behaviours that result from cognition) and the gradual acquisition of skills (McLeod, Plunkett, & Rolls, 1998).

A second appeal of dual coding theory is its grounding in embodied cognition (Sadoski & Paivio, 2013). According to the embodied cognition view, mental representations consist of sensori-motor information captured from our interactions with the environment (Barsalou, 2008; Barsalou, Simmons, Barbey, & Wilson, 2003). There is a growing body of research providing support for this view of cognition (Anderson, 2003; Wilson, 2002).

The third appeal of dual coding theory comes from its ability to account for the language process involved in writing. In fact, dual coding theory is first and foremost a theory of reading and writing (Sadoski & Paivio, 2013). Although it focuses more on the processes involved in reading, it also provides a strong framework for explaining the language processes involved in text generation (Paivio, 1991; Sadoski & Paivio, 2013). Given these benefits, dual coding theory will provide the theoretical framework for this research.

Dual Coding Theory

Dual coding theory states that there are two types of mental representations involved in language processing (Sadoski & Paivio, 2013). The verbal system consists of logogens, which are haptic, auditory, and visual linguistic representations of various sizes. The

nonverbal system consists of nested sets of imagens, which are nonlinguistic haptic, auditory, visual, olfactory, gustatory, and emotional representations. Processing involves spreading activation between logogens and imagens, referred to as referential processing, and through direct connections within either system, referred to as associative processing. Besides the type of representation, the other major difference between the two systems is the arrangement of those representations. The verbal system is predominantly hierarchical with strong sequential constraints on processing affecting the arrangements of phonemes/letters/morphemes to form words, words to form phrases and sentences, and sentences to form discourse. The nonverbal system, on the other hand, is embedded and therefore synchronously processed, such that all activated information is available at once, within the constraints of working memory and attention (Sadoski & Paivio, 2013). This synchronous activation allows one to imagine a whole scenario, "zoom in" to a specific detail of that scenario, or pan in any direction.

Dual Coding Theory and Development

According to dual coding theory (Sadoski & Paivio, 2013) the outcome of spreading activation during associative and referential processing is based on how often and how recently prior activation has occurred, as well as on the strength and number of excitatory and inhibitory connections that arise from past experience and context. Within this, as well as other connectionist frameworks, learning is seen as associative and development is seen as learning (Westermann, Ruh, & Plunkett, 2009). Repeated associations among logogens or imagens that arise from repeated unvaried experiences will result in highly probable connections and higher order integrated cognitive structures. When associative activation of logogens or imagens is more variable, due to diverse experiences, they remain as separate

structures. Furthermore, although the weights of connections within a given network result from experience, they are also impacted by the starting state of the network (McLeod et al., 1998). Different start states result in different rates and sensitivity to learning. In this way, new learning is affected by the foundation on which it is built.

Dual Coding Theory and Language Processing

Within the dual coding model, semantic representations consist of words in the verbal system and their related imagens in the nonverbal system. Vocabulary items are labels for underlying concepts, with words for concrete concepts linking directly to nonverbal sensory information and words for abstract concepts being processed via their associations with other words, but inevitably activating some nonverbal representation, albeit, more indirectly than occurs with concrete language (Sadoski, 2005). Semantic language processing, therefore, involves both associative verbal (word to word) and nonverbal (mental imagery) activations, but ultimately relies on referential processing between the two systems (i.e. between language and image; Sadoski & Paivio, 2013). From this point forward, semantic processing will refer to referential processing between the two systems, and semantic representations will refer to words and their corresponding nonverbal representations.

In contrast, syntactic processing of language is based on the form and hierarchical arrangements of words within a sentence. Consequently, syntactic processing can be seen within the dual coding model as primarily associative processing within the verbal system, which allows for the appropriate arrangement of activated linguistic representations. It should be noted that the hierarchical processing of the verbal system also takes care of the arrangement of phonemes and bound morphemes to form words; however, these aspects of linguistic processing are not of interest in this current study. From this point forward,

syntactic processing will be used to refer to the arrangement of words to form grammatically and syntactically correct sentence structures. Syntactic representations will refer to well learned phrase and sentence structures.

Differentiation of semantics and syntax. Given that language processing always activates verbal representations, the division between syntax and semantics is not definitive. As is the case with all cognitive models, it is important to consider what the relationship between these two processes is. The relationship between any two cognitive processes may be depicted in a number of ways, as shown in Figure 1.

Processes may be independent and exclusive of one another, such that processing in one component is completely separate from the processing in the other (Jones, 1987). A serial model of text generation would be consistent with such a view. For example, semantics may precede syntactic processing (Figure 1a) which would imply that semantic coding would be complete before syntactic coding was engaged. Furthermore, there would be no feedback from syntax to semantics. Conversely, syntax may precede semantics (Figure 1b) such that the syntactic frame of an utterance would need to be complete before semantic processing would occur, with no feedback from semantics to syntax. It is hard to imagine how a meaningful utterance could be generated in this way. Serial views of processing, such as these, are not consistent with dual coding theory, which claims that language processing involves spreading activation across a network and includes competing inhibitory and excitatory connections (Sadoski & Paivio, 2013) among representations. Competing connections imply feedback mechanisms, which do not exist in serial processing models (Jones, 1987).

Other accounts may explain semantics and syntax as overlapping. For example, processes may be seen as completely overlapping and redundant, such that processing in one component cannot occur without processing in the other (Jones, 1987; McDougall, Borowsky, MacKinnon, & Hymel, 2004). Such a model might imply that syntactic coding is a part of semantic processing (Figure 1c). With this arrangement, one could generate semantic information without syntactic coding (as in the generation of a list of semantically related words), but would not be able to syntactically generate language without semantic activation. Conversely, semantic activation could be part of syntactic processing (Figure 1d). In this case, one would be able to generate syntactically correct language that may or may not be semantically meaningful (as in the generation of syntactically correct nonsense sentences), but would not be able to generate semantic language without syntactic structure. As the generation of word lists and nonsense syntactic constructions are both possible language behaviours, a redundant relationship between semantics and syntax also seems unlikely.

Finally, processes can be considered independent but overlapping (Figure 1e), such that processing can involve one component or the other, or both (Jones, 1987; McDougall et al., 2004). A model such as this would account for the ability to generate a list of related words or name a picture, as well as the ability to generate novel nonsense but syntactically correct sentences. Additionally, this view of semantic and syntactic processes can also account for the fact, that for the majority of language use, both processes are involved. This view of semantic and syntactic processes as separate but overlapping is consistent with dual coding theory and supported by research examining the differentiation of the two processes.

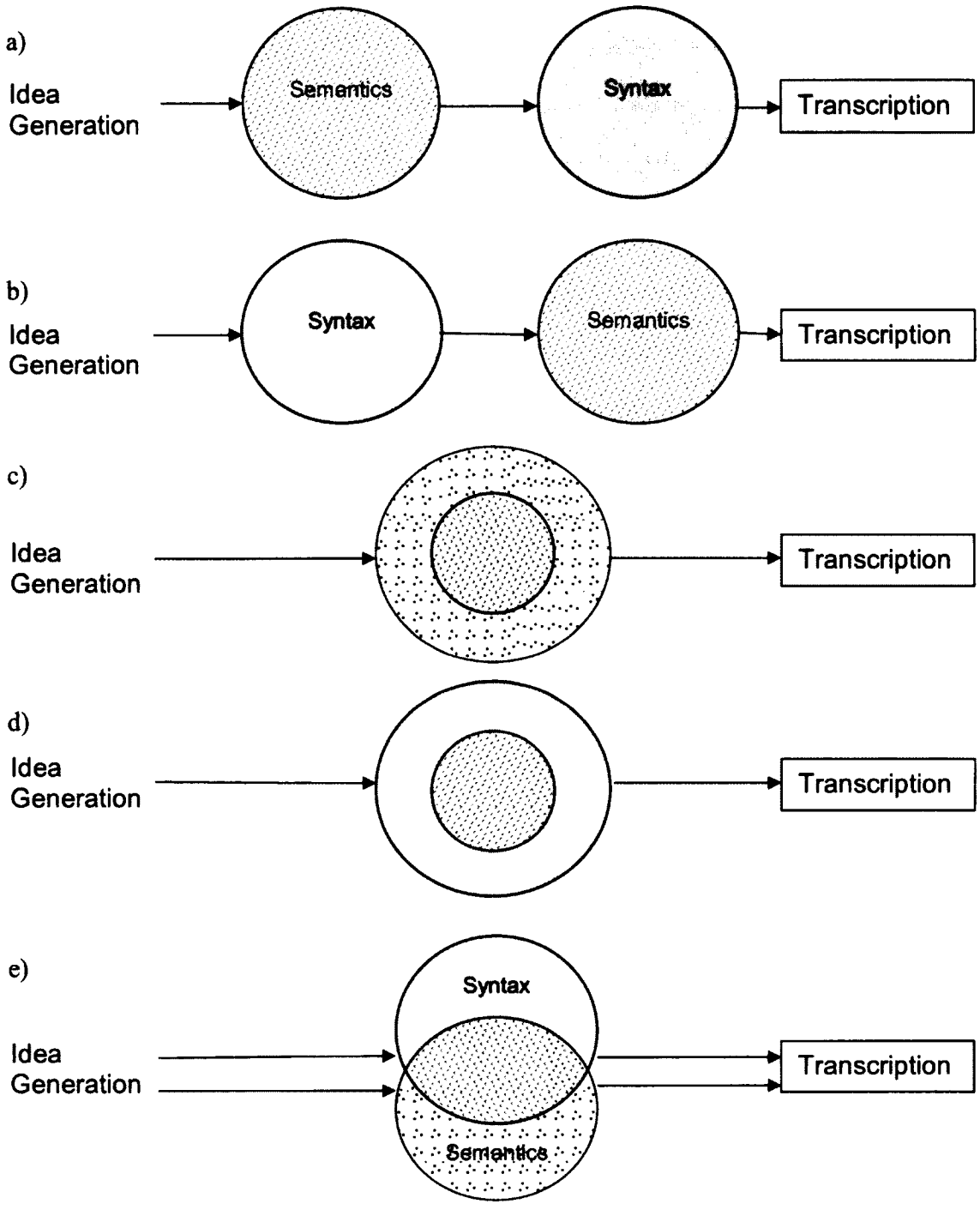

Figure 1. Five models depicting the possible relationships between semantic and syntactic processes in text generation.

One line of evidence supporting the differentiation of semantic and syntactic skills comes from research examining this relationship through standardized language testing. For example, Tomblin and Zhang (2006) found that a two factor model differentiating semantics and syntactic language tests had a better goodness of fit than a single factor model for children in Grades 2 and beyond. Furthermore, they found that, with advancing grade, the correlations among measures of syntax and semantics declined, showing increased differentiation of these two components of language over time. Similarly, in the development of the *Clinical Evaluation of Language Fundamentals* (CELF-4) Semel, Wiig, and Secord (2003) found that, despite correlations among subtests, semantic and syntax related tasks loaded on to separate factors in a confirmatory factor analysis.

Further support for the differentiation of semantic and syntactic language processes may also be inferred from brain localization studies. Semantic processing has been shown to be widely distributed (Feifer & De Fina, 2002; Kolb & Wishaw, 2009), whereas syntactic processing is confined primarily to the left hemisphere (Kolb & Wishaw, 2009), engaging Broca's area in the prefrontal cortex (Grodzinsky & Friederici, 2006), the basal ganglia, and the cerebellum (Dennis, 2010; Feifer & De Fina, 2002; Highnam & Bleile, 2011). However, there is an interaction between these two types of processing during text generation. That is, the widely distributed semantic functions are "stitched together" by Broca's area (Feifer & De Fina, 2002) to create coherent syntactic constructions, thus accounting for the overlap of processing in the two domains.

It is this view of semantics and syntax as independent but overlapping processes that guides this current research. I will next provide theoretical explanations for how these independent but overlapping linguistic processes contribute to text generation.

Dual Coding Theory and Text Generation

According to the dual coding theory account of composing (Sadoski & Paivio, 2013), writing begins with an external (instruction) or internal (imagery based) motivation. A mental representation of what is to be written is associatively active within the nonverbal system with spreading activation to the referentially connected words (i.e. semantic processing). Output is generated incrementally on a clause by clause basis, constrained by the sequential processing of the verbal system (i.e. syntactic processing). Thus, it is through the combination of these two types of processing that text generation occurs.

During text generation, semantic processing can be seen as more constrained by referential connections between the verbal (words and phrases) and nonverbal systems (corresponding images), such that a writer may have multiple or limited ways to express a single idea depending on prior linguistic experiences and the resultant breadth and depth of vocabulary. Syntactic processing, on the other hand, is more likely constrained by the learned hierarchical arrangements within the verbal system, such that a writer may have more or less complex syntactic arrangements available for the expression of a single generated idea. Likewise, larger arrangements of verbal information at the discourse level may be more or less activated, depending on prior experience.

Text generation and cohesion. The dual coding theory account of writing explains cohesion as arising from two potential sources. One source of cohesion is the activation of a coherent nonverbal mental model (Sadoski & Paivio, 2013). A strong coherent nonverbal mental model would referentially activate sequentially arranged words, phrases, and even sentences that match this model, allowing for the cohesive expression of that model. That is, a coherent mental model arising from semantic processes and representations contributes to

cohesive writing. A nonverbal mental model source supports the notion of cohesion as a semantic construct.

Another source of cohesion, according to dual coding theory, would arise from associative processing within the verbal system (Sadoski & Paivio, 2013). That is, connections among words, phrases, and sentences that "go together," along with associated conjunctions would be activated. In this way, syntactic processing can also be seen as contributing to cohesion.

Summary

Dual coding theory provides a detailed theoretical account of semantic and syntactic processing and representations, as well as text generation processes. Given the view of learning and development as experiential and dependent on the starting state of the given cognitive network, I argue that linguistic knowledge sets the starting state from which text generation skills develop. Linguistic knowledge, in the form of semantic and syntactic processes and representations initially is acquired from verbal language experiences. The resulting individual differences and variability in semantic processing and nonverbal representations, and syntactic processing of verbal representations, should result in variation in text generation, including the use of cohesive devices. This argument forms the theoretical foundation for the current research. I turn now to a review of the empirical evidence that supports the proposal that individual variation in syntax and semantics impacts the development of cohesion.

Research on Oral Language and Written Cohesion

Oral Language and Text Generation

There is a small body of research examining the relationship between components of oral language and writing development (Shanahan, 2006). However, the debate about the nature of this relationship is ongoing. Some have contended that the language processes used in writing are different from those used in conversation (Rubin, 1978). For example, Berninger's work over the last two decades has been based on the premise of four overlapping but independent language systems related to listening, speaking, reading, and writing. She refers to these language systems as language by ear, language by mouth, language by eye, and language by hand, respectively (Berninger, 1996). Similarly, Torrance and Nottbusch (2012) argue that translation processes used in speaking and writing must employ different semantic, grammatical, and phonological word representations. The basis of their argument is that writing does not involve the fluent production required by speaking, and that writing requires the addition of orthographic processing. These output differences, they argue, may require accommodation from differently structured conceptual and modal language processing. To back this argument, they cite lesion studies showing impaired writing processes where the comparative oral processes (e.g. written vs. spoken naming) are spared.

Despite the merit of these claims, it has been demonstrated that there is a reciprocal relationship between the different component processes of language. For example, it is well established that reading results in improvements in vocabulary and that better readers are better writers (Byrnes & Wasik, 2009). Young et al. (2002) found that there were strong and significant correlations among reading and writing skills in 19 year olds with and without

language impairments, with the strength of these relationships stronger for the individuals with language impairments. Similarly, Hay and Fielding-Barnsley (2009) found moderate positive correlations between children's receptive and expressive language skills and their early reading skills. Nation, Cocksey, Taylor, and Bishop (2010) demonstrated that co-occurring difficulties with vocabulary, listening comprehension, recalling sentences, and sentence structures existed in children who presented with reading comprehension difficulties.

Even though there is reciprocity between oral and literate language growth, in cases of typical development, speaking precedes writing and should therefore provide some predictive value in the rate and sensitivity to learning to write. Using structural equation modeling to establish the relationships among a number of developmental skills and written language, Abbott and Berninger (1993) found that oral language skill level contributed to the quality of compositions in the primary grades. They also found a relationship for children in the intermediate grades, but due to covariance between measures of reading and oral language, the relationship was less clear for this age group.

One of the limitations of this research was the measures of language used. Two of the measures focused on speech segmentation (shown to contribute to orthography). Another four of the measures came from the verbal subtests of the WISC-R (Information, Similarities, Vocabulary, and Comprehension), which are arguably better indicators of declarative knowledge than facility with syntactic and semantic language components. Only two of the measures reflected syntax and semantics– sentence memory and word finding – and only the latter of these two tasks reflects the generative language skills that are required in composition.

Similarly, in an exploratory analysis of children's early writing, Kim et al. (2011) found that oral language (as measured by expressive vocabulary, grammatical cloze, and sentence imitation), spelling, and letter writing fluency were predictive of the total number of words, sentences, and ideas written by beginning writers in narrative texts. Additionally, they found that once language, spelling, and letter naming were entered into the regression, reading was not significantly related to writing.

Text Generation and Cohesion

As indicated previously, the development of writing involves changes in the connectivity within and among parts of the text resulting in improvements in textual coherence. Coherence is defined as an overall characteristic of a text reflecting unity at the discourse level arising from how the text is written and from the reader's mental representations of that text (Graesser, McNamara, Louwerse, & Cai, 2004; Spiegel & Fitzgerald, 1990). As previously indicated, cohesion refers to devices used in the text that contribute to textual coherence.

As you may recall, three key types of cohesion commonly seen in the writing of children are reference, conjunction use, and lexical cohesion (Cameron et al., 1995; Crowhurst, 1987; Yde & Spoelders, 1985; Zarnowski, 1983). As writers develop, differences in cohesion arise not only from the devices used, but also from whether or not the ties clearly connect to something in the previous text, and how far away that connection is (Fitzgerald & Spiegel, 1986; McCutchen & Perfetti; 1982). For example, consider the following passage:

> One day *the*[1] boy was playing soccer. *He*[2] and his friend were having a lot of fun. *He*[3] even scored a goal. Suddenly it started to rain. *The*[4] game was cancelled and *he*[4] went home.

In this passage, we have examples of [1]ambiguous, [2]immediate, [3]mediated, and [4]remote ties. Ambiguous ties are those for which the intended referent was unclear. Such ambiguities may arise when the referent has not been stated, or when more than one possible referent is available. A tie is considered immediate if its referent is in the previous sentence. A mediated tie occurs when a referring pronoun, rather than the original referent, is mentioned in the previous sentence. Mediated ties help to form referent chains. A remote tie is the result of a broken referent chain, in which case interjecting sentences exist between the tie and the referent.

Development of written cohesion. Developmental studies of writing have found between grade differences in the use of cohesive devices. For example, in a study examining the expository and narrative writing of children in Grades 2, 4, 6, and 8, McCutchen and Perfetti (1982) found that the youngest writers used many unsuccessful connections. That is, they had the highest proportion of disconnected sentences in their writing. With advancing grade, there was an increase in connections, beginning with remote ties. Finally, their oldest students used the most immediate connections. They found the same pattern in narrative and expository texts, but the increase in local connectivity in narratives came earlier. Fitzgerald and Spiegel (1986) also found that children in Grade 6 had less distance between cohesive ties in their narrative writing than children in Grade 3, and this decrease in distance was associated with an increased holistic measure of coherence. Similarly, Yde and Spoelders (1985) examined cohesive density, a score that captures the number and distance of cohesive

devices, in the narrative writing of children 8 to 9, and 10 to 11 years of age. They found that the writing of the older children had higher densities of cohesive devices than the writing of the younger children.

Another developmental change found in cross-sectional studies examining cohesion in the writing of children is a decrease in the number of ambiguous ties with advancing grade. For example, Cox et al. (1990) found this pattern in both the expository and narrative writing of children in Grades 3 and 5. Likewise, Fitzgerald and Spiegel (1986) found this pattern in their study of children's narrative writing.

Another area of cohesion that shows developmental change is the variety of devices used. For example, Crowhurst (1987) found an increased variety of conjunctions used in the narrative and expository writing of children across Grades 6, 10, and 12. Similarly, she also found an increase in the variety of lexical cohesion across these grades, with older students using more collocation and synonyms than younger students. Rutter and Raban (1982) also found increased collocation with age, in their collection of poems and stories written by 6 and 10 year olds.

Although this body of research is not extensive, it provides evidence for developmental changes in cohesion. As advancing grade reflects increased practice with writing and subsequent improvements in writing ability, these studies provide evidence for a change in cohesion with advances in writing development.

Language and Cohesion

Given the relationship between oral language development and writing, it should not be surprizing that differences in language impact the development of cohesion in writing. Although research along this line of inquiry has not been extensive, a few studies have

investigated how individuals with language-learning disabilities use cohesive devices. Mortensen et al. (2009) found that adults with a history of language impairment were more likely to make errors in pronoun referencing compared to adults without language impairment. Liles (1985) found that children with language disorders used more incomplete or erroneous cohesive ties and relied more on lexical reiteration than those without language-learning disabilities. Likewise Hedberg and Fink (1996) found less cohesive density and harmony for students with language-learning disabilities compared to those without.

Differences in literacy skills have also been linked to differences in the kinds of cohesive devices used by children. For example, Cox et al. (1990) found that poor readers used more ambiguous ties (i.e. ties with referents that were unclear, exophoric, or too distant) in their writing than good readers. Though Cox et al. argued that these differences in cohesive knowledge arise from reading ability, it has been demonstrated that reading ability is also related to facility with oral language (Byrnes & Wasik, 2009). Thus, weaker oral language skills also may have contributed to the poorer use of cohesive ties for the unskilled readers in their study.

Collectively, combined findings from studies of individuals with reading or oral language differences demonstrate that effective use of cohesive devices in writing is linked with linguistic abilities. However, each of these studies focussed on how well students with and without impairments wrote and used cohesive devices without specification of the participants' individual differences in semantic and syntactic abilities. Given that language impairments can involve deficits in either semantics, syntax, or both, these studies provide little clarification for the role of component language processes in the development of cohesive writing. Further research therefore is required to examine the contribution of

syntactic and semantic processes to writing, to further specify models of writing, and help us to better understand the processes and skills which may facilitate the development of cohesive writing.

Summary

Writing cohesive texts is a complex task requiring linguistic processes. Changes in cohesion appear as writing develops, as changes in the cognitive processes involved leave traces in the produced text (Sanders & Schilperoord, 2006). The starting state of the cognitive network involved in writing, as well as rate of learning (thus development), is impacted by oral language development and language experiences. However, it is unknown which component processes of language have the greatest impact on cohesion in writing. Does cohesion emerge more so from a strong nonverbal mental model and subsequent semantic processing, or from stronger associative connections responsible for the syntactic arrangement of words and phrases within the verbal system? Maybe cohesion is equally weighted on both semantics and syntax, or perhaps some aspects of cohesion may arise from semantic processing (e.g. lexical cohesion) and others from syntactic processing (e.g. conjunction use).

Currently, the contributions of semantics and syntax to cohesion in writing are unknown. It is the aim of this research to examine these contributions. Understanding the differential contributions of semantics and syntax to written cohesion should help to specify the component processes involved in text generation, and the development of coherent writing.

Methodological Considerations

To effectively investigate the differential contributions of semantics and syntax to the development of written cohesion, careful attention to questions regarding the experimental design is required. First, given the overlapping nature of syntax and semantics, differences in the effects they produce may be subtle. Therefore, it is important to consider what type of design will allow for close examination of the differential contributions of the two types of linguistic processes to the development of cohesion. For example, it may be useful to use semantic treatments suggested by Sadoski (2005) to activate nonverbal representations and referential processing and syntactic treatments using conjunctions to activate verbal representations and sequential, associative processing. Second, careful consideration needs to be given to the instruments used to measure each of the variables of interest. In particular, it will be necessary to find assessment tools that differentially measure semantics and syntax. Finally, when using an experimental design, it will be important to use manipulations that have been demonstrated to impact semantic and syntactic skills. These considerations are addressed next.

Research Design

There are a number of designs that could be used to examine the differential contributions of semantics and syntax to the development of cohesion. Comparing the semantic and syntactic abilities of a group of children to their use of cohesion in writing is one approach. This approach offers a snapshot of how much semantics and syntax contribute to cohesion at a particular moment in development, which is useful, given the general lack of research investigating these contributions. However, this approach would not provide

information about how growth in semantics and syntax lead to developmental change in cohesion over time.

Developmental change typically is examined through either a cross-sectional or longitudinal design. A cross-sectional design would provide information about differences between groups, but not about intraindividual change. Longitudinal designs, on the other hand, can provide power in detecting intraindividual change over time (Abbott, Amtmann, & Munson, 2006), but often take extended periods of time to complete. This requirement becomes particularly challenging when conducting research in applied settings. In school settings, for example, stakeholders may change annually. New classroom teachers and administrators may not be as agreeable to participation in research as those who preceded them. Another concern is the loss of participants due to attrition. Finally, though longitudinal studies tend to provide information showing that a change has occurred, they generally do not provide information about what factors lead up to the change and what the change itself looks like.

An alternative method, the microgenetic design, allows for examination of the change process itself and avoids some of the research pitfalls that arise from the extended nature of longitudinal designs. This method allows for the examination of a change by simulating development and making high density observations throughout the period of change. The change may be induced by repeated exposure to tasks that are believed to be related to the change in question (Siegler & Crowley, 1991) and development can be measured by a change in overt behaviour. Microgenetic designs can be used when wanting to infer the processes that lead to changes in a given skill area. They also have the promise of potentially revealing information about the path, rate, breadth, and variability of change. Furthermore,

microgenetic designs are particularly useful for examining development in human cognition (Flynn, Pine, & Lewis, 2007; Kuhn, 1995; Siegler & Crowley, 1991). Given the purposes of this approach, it seems an appropriate choice for studying the contributions of semantics and syntax to the development of cohesion in the writing of children.

Considerations When Using a Microgenetic Design

Although microgenetic studies show promise in revealing detailed information about changes in processing (Siegler & Crowley, 1991), they have their complications. Firstly, when planning a microgenetic study, it is difficult to predict how much time will be required to elicit the change of interest. As well, because these studies involve repeated measures and small sample sizes, there can be difficulties with statistical analysis. Siegler and Crowley indicated that studies of this nature work best when descriptions of typical development of the skill are known thus allowing for the selection of appropriate age groups, treatment activities, and assessment techniques.

Age group. For this study, selection of an appropriate age group involves consideration of the developmental patterns for writing, language differentiation, and cohesion. Empirical evidence shows that writing is influenced by different processes at different stages. For example, in the primary grades (Grades 1-3) writing is most constrained by transcription processes (i.e. spelling and handwriting) whereas in the intermediate grades (Grades 4-7), writing is constrained more by linguistic processes. By the time students reach high school, cognitive skills (e.g. working memory and executive functions) place the greatest constraints on writing (Berninger & Swanson, 1994).

The differentiation of semantic and syntactic processes also changes with age. That is, prior to Grade 2 a single factor model accounts best for children's language skills, but by

the intermediate school years, these skills load on to separate factors (Tomblin & Zhang, 2006).

As previously indicated, cohesion also changes with age. Sometime around Grade 4, the number of unrelated sentences in children's writing decreases. That is, it is around this time that local connections between sentences emerge, and by the time children reach Grade 6, they are using immediate connections between the majority of their sentences (McCutchen, 1994). Additionally, students at the Grade 4 level are not yet able to strategically manipulate these connections in their writing (Berninger, Mizokawa, Bragg, Cartwright, & Yates, 1994). This fact is important because the interest of this research lies in examining implicit language abilities as contributors to written cohesion, rather than children's ability to strategically manipulate these devices. Consequently, it appears that students in Grade 4, whose writing is constrained by linguistic processes, whose semantic and syntactic skills show differentiation, and who are beginning to use more local cohesive ties in their writing, are in an optimal zone of proximal development to respond to experimental manipulations. For these reasons, Grade 4 appears to be the most appropriate target population for a study examining the differential contributions of syntax and semantics to written cohesion.

Treatment activities. Microgenetic designs often require some element of instruction or intensive practice to induce the desired change. To ensure the desired effect, the use of approaches that have been demonstrated to be effective in stimulating semantic and syntactic skills, is important. A review of the research suggests several interventions that may be effective in inducing change.

Semantic activities. Given the view of semantics as the connections between words and their related nonverbal representations, the search for semantic activities focused on vocabulary development. Several activities have been shown to improve vocabulary skills. For example, from their review of the outcomes of various interventions for children with language impairments, Steele and Mills (2011) developed several recommendations for effective vocabulary instruction. Included in their list are repeated exposures to new words, tying words to meaningful contexts, use of "child friendly" definitions (ones that connect new words to concepts a child already knows), exploring synonyms and antonyms, exploring examples and nonexamples, and discussing similarities and differences between new and known words. The use of visual organizers such as semantic maps and Venn diagrams, are also advised in vocabulary teaching (Sadoski, 2005; Steele & Mills, 2011). Another intervention technique shown to improve vocabulary learning is using atypical or sophisticated examples of semantic categories (Kiran, 2007; Steele & Mills, 2011). Furthermore, in keeping with dual coding theory, Sadoski (2005) recommended the use of pictures, visual imagery, and drawing to activate nonverbal representations during word learning.

Syntax activities. There is less literature citing best approaches to facilitate syntax learning. However, there is some evidence to support the practice of sentence combining. For example, in two large scale reviews of the impact of grammar teaching on writing, Andrews et al. (2006) found that sentence combining, defined as changing two simple sentences into a single compound or complex sentence form, was effective in improving syntactic complexity in the written output of English speaking children in Grades 4 through 10. Similarly, in their study of Grade 4 children, Saddler and Graham (2005) found that an

intervention of sentence combining led to significant improvements from baseline for scores on both an experimental measure and norm referenced assessment (*Test of Written Language*) of sentence combining.

Another promising technique is the use of complexity in syntactic interventions. Thompson and Shapiro (2007) studied the effect of complexity in syntactic treatments for adults with acquired language impairments impacting sentence structure. They found that interventions involving more complex sentence structures resulted in improvement for both complex and simpler structures that required similar transformations. For example, practice in moving noun phrases to create more complex sentences generalized to other constructions involving noun phrase movement, with more complex examples resulting in the best generalization. Conversely, interventions using more simple sentence constructions did not generalize to more complex forms. Although their findings were based on interventions for adults with acquired language disorders, the use of complexity in syntactic practice with children may also lead to better generalization of forms.

Finally, given the conceptualization of syntax as associative processing among sentence parts, and learning as increased weights for particular combinations gained from unvaried experience, then repetitive practice of sentence generation, should also lead to increased connections among verbal representations, and therefore syntactic learning. In particular, repetitive practice generating sentences that fit particular syntax patterns should facilitate learning of those patterns.

Oral Language and Written Cohesion Measures

Multiple methods of assessing semantics, syntax, and written cohesion are available; however, as with any research study, finding reliable and valid measures of the variables of

interest is imperative. In the case of semantics and syntax, the challenge lies in finding measures that capture one or the other, with limited overlap. For cohesion, it is also important to find measures that will capture the three types – reference, conjunction, and lexical cohesion – and provide enough detail to examine developmental change.

Semantic measures. To capture semantic processes, I looked for measures of vocabulary. I acknowledge that semantic processing encompasses more than just words and their meanings. However, because I am interested in examining semantic processes differentiated from syntactic processing, semantic skills in this study will be operationalized as the depth and breadth of vocabulary and will not include meaning elicited by phrases and sentences. Breadth refers to the size of an individual's vocabulary, and should reflect referential processes between words and their nonverbal representations. Depth of vocabulary refers to the relationships among words and should capture associative processing among nonverbal representations. Depth may be measured by definitions, synonyms, or word associations (McGregor et al., 2012).

One measure of vocabulary breadth, the *Peabody Picture Vocabulary Test* (PPVT; Dunn & Dunn, 2007), is a standardized clinical measure frequently used in studies of language. One advantage of the PPVT is that it has been shown to be a valid measure of vocabulary. For example, Gray, Plante, Vance, and Henrichsen (1999) found strong correlations between the PPVT and two other standardized measures of vocabulary (r = .724 to .777), attesting to its concurrent validity as a vocabulary measure. There is also evidence for the test's discriminant validity. For instance, in a study by McGregor et al. (2012), children diagnosed with syntax-based language impairments scored within the average range on the PPVT-3. Similarly, Ukrainetz and Blomquist (2002) found that scores on the PPVT-3

showed only a small relationship ($r = .17$) to a syntactic measure (mean length of utterance) generated from oral language samples of young children. Likewise, Condouris, Meyer, and Taber-Flusberg (2003) found that combined vocabulary scores from the PPVT-3 and the *Expressive Vocabulary Test* (EVT) did not correlate with syntax measures derived from oral language samples for children aged 4 to 14 years. Tomblin and Zhang (2006) also included an earlier version of the PPVT (Revised Edition) in their study examining the differentiation of semantics and syntax. They found that by Grade 4, the PPVT-R score loaded onto a separate factor from the syntactical measures of the *Clinical Evaluation of Language Fundamentals* (CELF – 3).

One method of assessing depth of vocabulary is through the use of a word association task (Schoonen & Verhallen, 2008). Word association responses have been demonstrated to differentiate among older and younger language users (Nelson, 1977), children with and without language disorders (Sheng & McGregor, 2010), and first and second language users (Schoonen & Verhallen, 2008). Additionally, word associations have been demonstrated to be strongly correlated to performance on word definition tasks (McGregor et al., 2012; Schoonen & Verhallen, 2008). In their study, McGregor et al. used a word association task in which children provided associations to word stimuli that included equal numbers of nouns and verbs, abstract and concrete words, and low and high frequency words. Equal representations for word types were designed to eliminate potential confounds associated with word factors. The word associations were then each coded as either unrelated, as a participle of the stimulus word, or as showing a thematic or paradigmatic relationship to the stimulus. This scoring procedure has been shown to effectively capture differences in vocabulary depth (McGregor et al., 2012; Nelson, 1977; Schoonen & Verhallen, 2008). A

word association task may also be useful in differentiating semantic skills from syntactic skills, as the single word responses do not require syntactic constructions.

Given this body of research showing the validity of the PPVT and word association measures, I plan to use these tasks to assess the breadth and depth of vocabulary of participants in this study. Given the conceptualization of semantics as referential processing between words in the verbal system and their nonverbal representations, I believe that these two measures will adequately capture the construct of interest.

Syntax measures. One reliable and valid standardized measure of syntax skills often used in research is the Formulated Sentence subtest of the CELF-4 (Semel et al., 2003). In its standardized presentation, the task involves the generation of an oral sentence in response to a picture and single spoken word cue. The sentence is then scored on the accuracy of its syntactic/grammatical form, as well as its semantic content. Consequently, it is not surprizing that scores on the Formulated Sentences subtest have been found to be moderately correlated to measures of semantic skills (McGregor et al., 2012; Semel et al., 2003). However, in two separate studies using confirmatory factor analysis, this subtest loaded onto a different factor than tests of word level semantics (Semel et al., 2003; Tomblin & Zhang, 2006), thus providing support for its use as a differentiated measure of syntax. Furthermore, this task involves the generation of novel sentences, thus it requires the language generation processes that are required for writing.

Another procedure for assessing oral syntax was described by Justice et al. (2006). They measured the oral syntactic skills of 250 children aged 5 through 12 years of age, from oral language generated in a spontaneous story generation task. They then submitted the generated samples to computer analyses using a program called *Systematic Analysis of*

Language Transcripts (SALT; Miller, Andriacchi, & Nockerts, 2011). They found that three measures generated by this program – mean length of T-unit[1] (MLTU), proportion of complex T-units, and total number of subordinating conjunctions – combined to form a single factor which they referred to as complexity. Using the eigenvalues derived from the factor analysis on the measures generated by the SALT program, they developed a formula that could be used to calculate a *complexity score* for oral language. When comparing across ages, they found that this score peaked at age 10 years with the biggest differences between 9 and 10 year olds. Additionally, there was a large degree of variability, suggesting that this measure may be sensitive to individual differences, particularly in the 9-10 year age group.

Another approach to measuring syntax was used by McGregor et al. (2012). They asked participants to provide oral sentences in response to the same spoken word stimuli that were used in their word association task. It has been suggested that variability in word type should result in variability in the sentences generated. For example, verbs tend to elicit more complex sentences than nouns (Bloom, 2000; McGregor et al., 2012) and abstract words elicit more complex sentences than concrete words (McGregor et al., 2012). Using this word set, McGregor et al. found that children with syntax impairments generated less complex sentences (as measured by clause density) than children without. Thus, examining syntactic complexity through a sentence generation task appears sensitive to variability in syntactic skills. Using a closed set of stimulus words rather than a more open narrative task to elicit oral language also has the advantage of controlling for confounds that may arise from differences in quantity and content of responses, allowing for the direct comparison of responses made by different children.

[1] A T-unit consists of an independent clause and any attached subordinating clause. T-units are often used in language research involving children, where oral productions or misuse of punctuation make sentence boundaries unclear.

In this study, I will use the Formulated Sentences task from the CELF-4, and a sentence generation task like the one used by McGregor et al. (2012) with the analysis of complexity suggested by Justice et al. (2006). Given the findings from previous research, these measures show promise in capturing syntactic skills as differentiated from semantic skills.

Cohesion measures. In an earlier review of the literature (Struthers et al., 2013) we found that a number of different approaches have been used in research to capture developmental changes in cohesion in the writing of children. These approaches include counts and proportions of the different types of cohesive devices used, measures of distance, and counts of ambiguous ties. The results from developmental studies of cohesion, as reviewed earlier, suggest that developmental change in cohesion may be captured by examining the variety of devices used, the distance among ties, and the number of ambiguous ties. Fitzgerald and Spiegel (1986) captured all three of these components in their study evaluating cohesion in the narrative writing of children in Grades 3 and 6. They accounted for the variety of devices used by counting the number and types of reference, conjunctive, and lexical ties. Additionally, to account for distance, they tallied the number (and distance) of immediate, mediated, and remote ties. They also calculated a mean distance for each story. The distance of each mediated and remote tie was the number of sentences between the original referent and the tie. Finally, they also counted the number of ambiguous or incomplete ties. One of the advantages to this type of cohesion analysis is that it allows for a detailed examination of differences in cohesion. One of the disadvantages to this approach is that it involves extensive hand coding, and as such, may introduce error into a study.

Another method for measuring cohesion is use of a web-based analysis tool called *Coh-Metrix* (Graesser et al., 2004). Coh-Metrix 3.0 (Institute of Educational Science, 2012) automatically calculates 60 linguistic indices of word characteristics, cohesion, and coherence of written texts. Three Coh-Metrix 3.0 measures capture the categories of cohesion commonly found in the writing of children, namely anaphor overlap, Latent Semantic Analysis (LSA), and the incidence of connectives. Anaphor overlap is calculated by assigning a score of 1 for each pair of sentences in which the second sentence contains a pronoun that refers to a noun or pronoun in the first sentence. If no such reference exists, the sentence is given a score of 0. The anaphor overlap score reflects the mean score for all sentence pairs in the text resulting in a score that ranges between 0 and 1. This measure therefore captures immediate referential cohesion. Latent Semantic Analysis (LSA) is an index of semantic overlap between sentences. According to Landauer, Foltz, and Laham, (1998), LSA is a mathematical representation of the relationship of words to the context in which they appear. As such, sentence adjacent LSA measures immediate lexical cohesion as it captures reiterations and collocation between sentences. LSA values, as computed in Coh-Metrix range from 0 to 1, with 1 representing high cohesion. The final measure of interest, the incidence of connectives, reflects the number of connectives units per 1000 words. It captures the density of conjunctions, and thus is an indicator of conjunctive cohesion.

Coh-Metrix has been demonstrated to provide reliable and valid measures of cohesion (Grasser et al., 2004; McNamara, Crossley, & McCarthy, 2009). For example, McNamara, Ozuru, Graesser, and Louwerse (2006) manipulated passages from children's books to have high or low cohesion, then submitted these texts to Coh-Metrix (Version 1.4) for analysis. They found that the high cohesion texts generated higher scores for coreference

(a predecessor to anaphor overlap), LSA, and connectives than low cohesion texts. Using a discriminant analysis, McNamara, Louwerse, McCarthy, and Graesser (2010) also found that Coh-Metrix (1.4) scores of LSA, coreference, and connectives, significantly predicted high and low cohesion texts.

One of the benefits of using Coh-Metrix is that it allows for the analysis of a large number of texts in a relatively short time. Additionally, machine scoring provides reliability in measurement. However, the values provided by the program do not provide much in the way of detail, and may not provide the richness of data required for a comprehensive analysis of changes in cohesion.

Summary

To study how semantics and syntax relate to the development of cohesion, two complementary approaches will be used. Assessments of children's language skills and their written cohesion will capture a snapshot of how children's existing level of semantics and syntax development relates to their current use of cohesion. To capture more specific information about the path and rate of change in using cohesive devices, a microgenetic design[2] will be used. To examine the differential contributions of semantics and syntax to cohesion, a microgenetic design involves the use of treatment activities delivered intensively to children most likely to show the desired change in cohesion, which in this case are children in Grade 4.

For both assessment and microgenetic designs, the study of contributions of semantics and syntax to written cohesion requires that reliable and valid measures of the variables of interest are used. The literature suggests that the PPVT and a word association

[2] This study will use the elements of a microgenetic design; however, microgenetic *analysis* of the data will be the focus of future studies.

task should be useful in differentially measuring vocabulary; the Formulated Sentences subtest of the CELF-4 and the complexity measure developed by Justice et al. (2006) should differentially measure syntax; and Coh-Metrix will provide a reliable and valid measure of cohesion, while hand generated scores should provide the details required for more in-depth analyses.

The Current Study

In this review of the literature, I have shown that the relationships between implicit semantic and syntactic abilities and the development of cohesion in writing are not well established. In fact, language processes are absent from most cognitive models of writing. Dual coding theory offers some promise in conceptualizing the role that semantic and syntactic processes and representations play, but empirical evidence is lacking. Previous research has shown that differences in cohesion are associated with both language and writing development; however, the differential impacts of semantic or syntactic skills on the development of cohesion are not clear. This research was designed to examine these relationships, to help clarify the differential contributions that semantic and syntactic skills make to the generation of cohesive texts. The proposed research is designed to answer the following questions:

1. What is the relationship between the semantic and syntactic components of language and the development of cohesion in the writing of children?
2. Is cohesion an emergent property of semantics, syntax, or both?
3. Does variation in syntactic and semantic skills of children relate to differences in the way they use cohesive devices?

The proposed research involves two approaches to answering these questions. First, I will assess children's present skills in semantics, syntax, and written cohesion. A regression analysis of these measures will allow for the examination of the relationship between these linguistic abilities and the use of cohesive devices. If cohesion is an emergent property of semantics, then measures of semantic skills should have a stronger relationship to cohesion measures than measures of syntactic skills. If cohesion is an emergent property of syntax, then there should be a stronger relationship between measures of cohesion and syntax, and weaker relationships with semantics. If cohesion is an emergent property of both semantic and syntactic development, then we should expect to see that measures of cohesion relate similarly to measures of syntax and semantics, or that different types of cohesion relate to different language skills.

Next, by stimulating the semantic or syntactic language skills of children using a microgenetic design, I will be able to examine how semantic and syntactic skills influence changes in how children use cohesive devices in their writing. One group will receive treatment focused on semantic language skills. Another group will receive treatment focused on syntactic language skills. A third group will not receive any language treatments. If development in the use of cohesion is an emergent property of semantics, then we should expect to see changes in the use of cohesive devices by children in the semantic group, but not in the syntactic or no treatment group. If cohesion is an emergent property of syntactic skill development, then we should expect to see a change in the way cohesion is used by children in the syntax group but not in the semantic and no treatment groups. If development in cohesion is an emergent property of both semantics and syntax, we should expect to see

changes in cohesion in both treatment groups, with the possibility of different types of cohesive devices being influenced by different treatment conditions.

Contributions of this Research

Understanding the contributions of syntax and semantics to the development of cohesion has both theoretical and practical importance. From a theoretical standpoint, in addition to addressing the specific questions posed here, this study will add to the limited body of research examining the relationship between language development and composing skills. Currently, it is much easier to find studies of translation processes in writing that focus on transcription (i.e., spelling and handwriting). Studies of text generation processes, where they exist, often focus on the role of working memory and strategic functions. The contribution of language skills in text generation has been less well studied (Shanahan, 2006) and could benefit from further investigation (Berninger, Nielsen, Abbott, Wijsman, & Raskind, 2008). In studies that have examined language, many have focused on comparing participants on the basis of overall language abilities (e.g. disordered vs. typical language development, good or poor readers, etc.) or, when examining individual differences, on the levels of language (word, sentence, paragraph) rather than semantic/syntactic distinctions. This research will therefore add to our understanding of the language processes that support writing development. Furthermore, examining the contributions of semantics and syntax may provide us with a better understanding of these component processes and their relative weights in composing (Whitaker, Berninger, Johnston, & Swanson, 1994).

Additionally, this research will help to elucidate how cohesion develops in the writing of children. Although there have been some convergent findings in developmental studies of cohesion (i.e. a decrease in distance and errors, and an increase in lexical cohesion

and variety of devices used), there has been substantial disagreement as to what cohesion actually is. That is, it is not clear whether cohesion constitutes a semantic or syntactic construct, or even whether or not it constitutes a single construct (Struthers et al., 2013). Therefore, examining the separate effects of semantic and syntactic development on cohesion will provide further evidence to support the definition of the construct(s) of cohesion.

The practical importance for understanding the contributions of language to writing in general, and cohesion specifically, come from the instructional and assessment implications of such information. If growth in writing development involves creating more coherent texts and this developmental progression is marked in children's writing by an increase in local connections among sentences, then understanding the use of cohesive devices, and the language development that underlies their use, will help educators and child development specialists (e.g., psychologists and speech-language pathologists) recognize the factors that may impact the development of compositional skills. Understanding the relationship between oral language developments and cohesion will therefore provide direction for both assessment and instructional practices. That is, assessment of oral language areas that are found to be strongly related to cohesion may be warranted for children who present with difficulty composing coherent texts. Conversely, children identified with particular language difficulties may require close monitoring of writing development.

A relationship between oral language skills and the use of cohesion in writing would also suggest that oral language skills warrant intervention when students present with difficulties composing coherent written texts. Current popular trends in writing interventions have placed emphasis on fluency in transcription and strategy based interventions (Graham & Harris, 2012), while language instruction is largely overlooked. However, implicit use of

linguistic devices precedes metacognitive or strategic control (Whitaker et al., 1994). If the use of cohesive devices develops as an emergent property of implicit oral language skills in either or both semantic and syntax domains, then these oral language skills may need to be addressed before writing interventions aimed at strategic control will be effective.

Understanding the differential contributions of semantics and syntax to cohesion will contribute to the understanding of individual differences and the ability of educators to provide differentiated instruction. Addressing the specific underlying language issue that relates to writing development is important because deficiency in a single underlying language process can have a bottleneck effect on the processing operations that rely on that deficit area (Pugh et al., 2006). Furthermore, Whitaker et al. (1994) proposed that a child with one pattern of abilities among word choice, sentence construction, and discourse organization may experience more frustration in text generation than a child with a different pattern. Similarly, a child who has relative strengths in semantics and weaknesses in syntax may demonstrate more or less difficulty in learning to write connected text, compared to an individual with the opposite profile. If it can be demonstrated that the development of cohesive writing is impacted more so by one or another process of semantics or syntax, then assessment and intervention in that specific area becomes warranted when encountering children who struggle to compose cohesive texts.

Finally, it is unknown whether programs aimed at oral language improvement would have an impact on writing achievement (Andrews et al., 2006; Shanahan, 2006). While this research is not an investigation of treatment effectiveness, findings from this study will help to clarify some of the connections between oral and written language development, and could therefore provide direction for future intervention studies.

CHAPTER 3

Method

This study consisted of two experiments. To examine the relationship between semantic and syntactic oral skills and the use of cohesive devices in writing, in Experiment 1, I compared pretreatment measures of oral syntax and oral semantics to measures of cohesion in writing for all participants. To further examine the effect of semantic and syntactic skills on cohesion, in Experiment 2, I used a manipulation coupled with a microgenetic design involving focussed practice with semantic or syntactic skills. This experiment was designed to address the question of whether cohesion is an emergent property of semantic or syntactic knowledge and processes, or both.

Participants

Seventy-eight students in Grade 4 were recruited from four schools in Prince George School District No. 57. Recruitment proceeded one school at time, beginning with the largest elementary school and working down the list of local schools by population. With permission of the building principal, an information meeting was held with the Grade 4 teachers from the respective building. When a teacher agreed to the study, all Grade 4 students in that class were invited to participate. Two large schools with enough Grade 4 participants to meet the desired sample size were initially recruited. However, the return rate for consent forms was only 65%, so a third school was required. That school generated only four returned consent forms so a fourth school was recruited.

The resulting sample consisted of 46 girls and 31 boys. The median age of participants was 9 years 9 months. The youngest participant was 8 years 7 months and the

oldest was 10 years 5 months. Nine of the participants were bilingual, three of whom spoke a language other than English as their first language.

Ethical Considerations

In order to conduct this study in the school district, I first sought permission of school district administration. To obtain consent of the district, Prince George School District No. 57 requires researchers to complete an "Application and Agreement for Access to Personal Information for Research or Statistical Purposes" form. Additionally, I was required to provide information about the research project to the Director of School Services. Information was provided in written form as well as in a face-to-face meeting. The district also required a copy of approval from the University of Northern British Columbia's Research Ethics Board (REB). Upon completion of this process, the Director of School Services granted permission and sent information to all elementary school principals indicating that I may be contacting them. At that point, I was able to begin recruiting schools. Copies of the REB approval letter, district information, principal permission, and teacher information forms are included in Appendix A.

Consent. A number of measures were taken to ensure informed consent of participants. Once a school was recruited, information about the study was provided to parents through a note in the school newsletter, an information letter sent home, and an invitation to an information night. (See Appendix A for a copy of the information letter.) In each of these sources of information, I also provided a website address that parents could visit to find out more information about the study. This website also provided audio-visual presentations about the study, the consent and withdrawal process, and a step-by-step guide to understanding and filling in the consent form. Written consent of parents and informed

verbal assent from the child participants was obtained prior to collecting any data. A copy of the consent form is included in Appendix A. In Experiment 1, assent was obtained prior to the individual language assessment. In Experiment 2, assent was obtained at the beginning of the treatment period, with follow-up reminders of the right to withdraw at the beginning of each treatment week and when individual participants were perceived as reluctant to participate.

Confidentiality. To protect the identity of the individual participants, teachers, and schools, each participant was assigned an identification number. All assessment protocols and writing samples were identified by number only. Name and demographic information associated with each identification number, along with the signed consent forms, were kept separate in a locked cabinet at UNBC. Demographic information included month and year of birth, indication of any second language learning, date of initial assessment, gender, school, and class. Only the primary researcher had access to this information[3] (although, it should be acknowledged that the research assistants (RA) were familiar with the children's first names and teachers' names as a result of their interaction with participants in the schools). All RAs signed confidentiality agreements.

When digital video recording was used to document treatment integrity, the recording device was trained on the group leader to avoid capturing participants' images. Nobody but I and the recorded group leader saw the video. Once viewed, the recordings were immediately erased. All original writing samples were returned to the participants' teachers.

[3] The RA who was assisting with the language assessments also had access to demographic information during the assessment phase as she was required to record assessment dates on the demographic information form. Following her involvement in the study, she no longer had access to this information.

Protection of participants. The primary researcher and all assistants underwent criminal record checks with the school district. Results of these checks were retained by the Director of School Services.

Experiment 1

Procedures

Participants returning signed consent forms were informed of the purposes of the study and their assent was obtained. One participant subsequently withdrew partway through the oral language assessment, resulting in a total of 77 participants for this experiment.

I, or a single trained RA, assessed each participant's oral language skills in a one-on-one session of approximately 45 minutes. Training of the RA included review of the scripted assessment procedures, demonstration, and practice. Additionally, before allowing her to work with children in the schools, I observed the RA while she assessed a volunteer child, to ensure she was proficient in assessment procedures.

Language testing was followed by a group administered written language assessment involving all participants from each school writing at the same time. Due to absences on the day of the group writing activity, six participants in total completed the writing assessment in separate sessions.

Assessment of each participant included two measures of oral semantics, two measures of oral syntax, and cohesion measures generated from two writing samples. To capture greater variance in each language domain (Shanahan, 2006), two measures, rather than a single measure, of each oral language area were collected. Similarly, two writing samples were collected to increase the reliability of the writing measure (Gerbil, 2009).

Oral language measures included norm-referenced standardized language tests and elicited language tasks. For the standardized tests, only raw scores were recorded as the scores were intended for within sample participant comparisons only. The elicited semantic and syntactic language tasks were generated from a set of 40 word stimuli, following a procedure used by McGregor et al. (2012). The 40 word stimuli, presented in Table 2, consisted of 20 verbs and 20 nouns. Half of the words were high frequency and half were low frequency. As well, half of the words were abstract and half were concrete.

The order of language tasks was counter-balanced, with half of the participants completing the vocabulary tasks first, and the other half completing the syntactic tasks first. Within each domain, the standardized measures were completed first, followed by the elicited tasks. A short break was taken between semantic and syntactic tasks during which time the examiner played three games of Tic-Tac-Toe with the participant as a distractor.

The procedures for generating the writing samples were designed to control as much as possible for genre and content. For each writing sample, the participants first watched a 5 minute *Pingu*[4] video clip. Following the video clip, participants were instructed to write a retell of the content for their teacher who did not see the video, and were given 15 minutes to write. The instructions given to participants are included in Appendix B. By using a video rather than a story retell, I avoided the potential constraints placed on the writing by the language provided in the initial telling of the story (Puranik, Lombardino, & Altmann, 2008). The order of video clips was counter balanced across groups of writers resulting in

[4] *Pingu* is a series of short claymation animations about a penguin. Each clip is approximately five minutes long and contains a full narrative structure (problem-resolution). Additionally, these videos do not include any dialogue allowing for the language generated by the student to be their own rather than what was modeled in the video.

approximately half of the participants writing Story One first and the other half writing Story Two first.

After the stories were written and collected, they were transcribed into a text file identified by participant number only. Samples then were corrected for spelling, and divided into T-units (independent clauses with attached subordinating clauses). Spelling was corrected to allow for computer scoring as the Coh-Metrix program does not recognize incorrectly spelled words. Words were not corrected if the error was grammatical in nature or if a word was omitted entirely. T-units were used to standardize sentence boundaries, as not all participants used capitals and periods to mark sentences in their writing. Each sample was proofread by the typist, and a second reader.

Semantic measures. For the purposes of this study, semantic skills were operationalized as scores derived from tasks aimed at capturing the breadth and depth of vocabulary. The breadth measure consisted of the *Peabody Picture Vocabulary Test* (PPVT-4; Dunn & Dunn, 2007) following the standardized procedures and scoring instructions outlined in the manual. This assessment required the participant to point to one of four pictures that corresponded with a word spoken by the examiner.

The depth measure of semantics was generated from an elicited language task. To measure the depth of vocabulary, a word association task, as described by McGregor et al. (2012) was used. In this task, participants were asked to say the first word that came to mind in response to a spoken stimulus word. The word order was randomized once so that all participants were presented with the same ordered list for this task. Responses were then judged on the basis of their semantic relationship to the stimulus word. Responses with no recognizable relationship to the stimulus received a score of 0 (e.g., repetition or rhymes of

the stimulus words); minimally related or idiosyncratic responses received a score of 1 (e.g., *Sandra* in response to *love)*; responses with thematic relationships to the stimulus words received a score of 2 (e.g., *family* in response to *love*); and responses reflecting paradigmatic relationships received scores of 3 (e.g., *adore* in response to *love*). Due to the interest in differentiating semantic from syntactic language processes, responses that were participles (e.g., *you* in response to love) or derivatives of the stimulus (e.g., *lovely* in response to *love*) received scores of 4 and 5 respectively, but were not added into the total score.

To ensure reliability in scoring, two independent raters scored each protocol. All disagreements were settled by consensus, resulting in 100% interrater agreement on the final scores. When disagreements were found, we clarified the scoring rules, and reviewed previously scored protocols to ensure consistency with the adjusted rule. The detailed scoring rules generated for this task along with a list of common responses are presented in Appendix C.

Syntax measures. For the purposes of this study, syntactic skills were operationalized as the participant's scores on tasks involving the oral formulation of syntactically correct complex sentences. The first measure consisted of the Formulated Sentences subtest of the *Clinical Evaluation of Language Fundamentals* (CELF-4; Semel et al., 2003). The standard procedures for this task require the participant to formulate a sentence using an orally provided word in response to a presented picture. Word stimuli consist of different parts of speech (e.g., nouns, verbs, and coordinating and subordinating conjunctions) designed to elicit a variety of simple and complex sentence forms. One difficulty with the Formulated Sentences subtest, for the purposes set out here, is that the scoring includes consideration of the semantic correctness of the sentence and its relationship

to the picture stimulus. To further separate the syntactic and semantic aspects of this task, the items were administered without reference to a picture, and the scoring procedure was modified to ignore semantic errors. The modified scoring rules are presented in Table 3. Due to the modified scoring procedures, and the element of judgement required in scoring some of the items, two raters separately scored each Formulated Sentences protocol to ensure interrater reliability in scoring. Discrepancies were settled by consensus.

The second syntax measure was derived from the elicited language task, using the same words used to elicit word associations. The word order was randomized again, and all participants were presented with the same ordered list. For this task, participants were asked to orally generate a sentence using each stimulus word. Sentences were transcribed directly by the examiner and computer scored using *Systematic Analysis of Language Transcripts* (SALT: Miller et al., 2011). I then calculated a complexity score, using the output from SALT and the formula[5] developed by Justice et al. (2006).

Cohesion measures. Cohesion measures were derived from the web-based program, *Coh-Metrix* (Graesser et al., 2004). Coh-Metrix 3.0 automatically calculates measures of cohesion, three of which will be used in this study to operationalize reference, conjunction, and lexical cohesion. They are anaphor (ANA) overlap (adjacent sentences), the incidence of all connectives (CON), and Latent Semantic Analysis (LSA) overlap (adjacent sentences mean), respectively. Coh-Metrix scores of the two samples from each participant were combined to form a single score for each type of cohesion. Appendix D contains a list of dependent variables, and the types of cohesion they measure.

[5] Complexity = -2.84+(0.27 x MLTU) + (0.85 x PROCOMPLEX) + (0.012 X NDW) + (-0.0027 x TNW) + (0.028 x COORD) + (0.026 x SUBORD) + (0.085 x LENGTH) + (0.14 x COMPLEX)

Table 2

Word Stimuli for Elicited Tasks Arranged by Word type, Abstractness, and Frequency

	Noun		Verb	
	Concrete	Abstract	Concrete	Abstract
High	chair	energy	eat	believe
Frequency	farm	fact	draw	consider
	machine	health	push	decide
	river	law	stretch	enjoy
	table	purpose	walk	love
Low	carrot	emergency	fasten	advise
Frequency	coin	loyalty	pronounce	complain
	garage	mystery	shove	persuade
	helmet	origin	squeeze	suspect
	magnet	terror	soak	worship

Note. Words were classified as concrete or abstract on the basis of > 89% agreement by 10 adults by McGregor et al. (2012).

Table 3

Modified Scoring Criteria Used in the Scoring Formulated Sentences

Score	Criteria
0	Stimulus word omitted
	Word form changes (unless dialect based)
	Word misused as another part of speech (e.g., "Longest ate the ice cream.")
	Incomplete sentence or fragment
	Complete sentence with more than 2 grammatical or syntactical errors
1	A complete sentence with only one or two deviations in syntax or grammar.
2	A complete sentence that is syntactically and grammatically correct.

Analysis

To determine the relationship between oral semantic and syntactic language scores and written cohesion, three separate regression analyses were conducted. Semantic and syntactic oral language scores were entered as the independent variables, and each Coh-Metrix score was entered as the dependent variable in each regression. I expected that syntax scores would predict CON and semantic language scores would predict LSA. Examination of the relationships of oral semantics and syntax to ANA were exploratory.

Experiment 2

Procedures

Forty-five participants took part in Experiment 2. These individuals were a subset of those children from the first (A), second (B), and fourth (C) schools, who participated in Experiment 1. Participants from the remaining school were excluded from this part of the study as there were too few to allow for random assignment or to create a full-size treatment group. One student also was removed from the selection pool due to parental request. Participants were invited to Experiment 2 if their syntax, semantic, and cohesion scores fell within 2.0 standard deviations of the mean, and English was their first language. This approach was taken to create treatment groups that were relatively homogeneous with participants who could write adequately well, and would be able to respond to the language treatments. Consent forms were sent home with all participants meeting these conditions.

All children returning consents participated in Experiment 2. School A had 20 participants allowing for the creation of four groups of five participants each, School B had 15 participants allowing for three groups, and School C had 10 participants allowing for two groups. There were 31 girls and 14 boys. Ages ranged from 9 years two months to 10 years 2

months, with a median age of 9 years 8 months. One group from each school was assigned to the control condition. Due to the uneven number of groups per school, treatment conditions were then randomly assigned to the remaining six groups by drawing group numbers out of a hat; however, one switch in treatment conditions between two schools was required to avoid overlap between schedules for the RAs running the semantic groups. Participants were then randomly assigned to groups. The distribution of treatment groups by condition across schools is presented in Table 4.

I and four trained RAs carried out Experiment 2 over a four week period. Treatment groups were scheduled for 30 minutes daily for the duration of the four week period. Control groups where scheduled for only 15 minutes daily to eliminate any unnecessary time out of the classroom. During the four week block one day was lost to a professional development day, and one each to a school disruption (e.g. a field trip) in two of the schools. Two sessions were also devoted to mid- and posttreatment writing sample collection. As a result each group participated in 16 treatment sessions over the four week period. Each treatment session consisted of 20 minutes of language activities followed by 10 minutes of writing. The control group did not receive any treatment but wrote for 10 minutes daily.

The daily writing activity involved writing a narrative from a picture, sentence, or combined picture and sentence prompt, depending on the condition. All prompts suggested topics and themes that I judged to be typical to the experience and background knowledge of children in this geographical region and age group and topics were consistent across conditions. A list of the writing topics and prompts by session is available in Appendix E. Other than clarifying instructions, the participants were not provided any help with writing.

If participants asked for help, they were instructed to try their best. It should be noted that requests for help were almost exclusively enquiries about spelling.

During the middle and final sessions of the treatment phase, all participants from each school were gathered for a 50 minute session. During this session, they wrote two texts generated after watching two *Pingu* video clips, following the procedures outlined in Experiment 1. These writing samples were used for the purposes of group comparisons, with the writing samples generated in Experiment 1 serving as the pretreatment measure. Video order was counterbalanced by group, with the largest school writing in the opposite order to the other two schools.

Conditions. Fifteen participants in total (three groups of five participants) were assigned to each of the conditions. Groups of five were used to ensure that the treatment intensity would be high for each of the participants. The first condition engaged participants in activities aimed at oral semantic skills. The second condition engaged participants in activities aimed at oral syntactic skills. The third condition acted as a control.

Semantic condition. In the semantic condition, oral language activities for each session centred on a specific semantic theme with all sessions in a given week related to an over-arching theme. In each session, participants were presented with pictures and led through a visualization exercise prior to beginning the language activities. Activities consisted of naming pictures, generating words that came to mind, building semantic webs and Venn diagrams to depict relationships among words, finding and generating synonyms and antonyms, and drawing pictures to reflect the meaning of newly learned words. The writing topic for each day reflected the semantic theme. During the writing activity,

participants in this condition wrote from a picture story starter. A sample session script is available in Appendix F.

Syntax condition. In the syntax condition, no semantic theme was used. Instead, participants had oral practice combining sentences, and producing sentences using a variety of syntactic frames and conjunctions. Stimuli for sentence generation tasks included random word and phrase cards, written sentence frames, and phrases spontaneously generated by the participants. During the writing activity, participants in this condition wrote from a sentence story starter. A sample session script is available in Appendix F.

Control condition. Participants in the control condition did not receive any language treatment, but they did participate in the daily writing activities. The writing prompt for this group consisted of a combined picture (from the semantic condition) and sentence (from the syntax condition) story starter. This combined prompt was used to create a writing condition that was comparable to both treatment conditions. A sample session script is available in Appendix F.

Research assistant training. The RAs involved in this study were all undergraduate psychology students with previous experience in working with groups of children. Each RA was trained to lead only one of the treatment conditions to avoid cross contamination. Each treatment group was assigned two leaders. I participated in running one of the treatment conditions and ran the control conditions.[6] The two leaders assigned to each group then alternated treatment sessions so that a group session was run by one leader one day, and the other leader the next. This arrangement allowed for a reduction of researcher effects on treatment conditions. Table 5 shows the distribution of leaders to treatment groups.

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[6] It should be noted that due to medical reasons, I had to arrange for coverage of some of the control conditions by other leaders.

Table 4

Number of Groups for Each Condition in Each School

School	No. of Groups		
	Syntax Condition	Semantic Condition	Control Condition
A	1	2	1
B	1	1	1
C	1	0	1

Table 5

Distribution of Leaders to Treatment Groups

	Conditions								
	Syntax			Semantics			Control		
Group									
Leader	1	2	3	1	2	3	1	2	3
Primary	+		+				+	+	+
RA 1		+	+						
RA 2	+	+							
RA 3				+	+	+			
RA 4				+	+	+			

Note. Primary = lead researcher; RA = research assistant; + = group lead by the corresponding group leader.

RAs received approximately 12 hours of training in their respective conditions. During this training, they were given background information on the study and their condition, and each of the tasks that would be used in the treatment was explained and demonstrated. We then role played and rehearsed mock sessions until group leaders demonstrated understanding of the activities and fluency with delivery of the treatment protocols. To ensure treatment integrity, each session followed a similar routine, and treatment activities were scripted. Assistants also completed self-assessments through reflective journaling directly following each session. Additionally, each group leader was digitally video recorded three times during the treatment study at random intervals. The RA and I then reviewed the video to ensure there was adherence to the treatment protocol and to troubleshoot any areas of difficulty. Following these procedures, RA adherence to treatment protocols was judged to be satisfactory.

Measures. All mid- and posttreatment writing samples generated by the participants were transcribed into a text file, proofread twice, divided into T-units, and corrected for spelling following the same procedures used in Experiment 1. Writing samples were identified by number only to protect the identity of the participant and allow for blind hand scoring. Samples were submitted to computer analyses of cohesion and productivity, and hand coded to allow for more detailed examination of cohesion changes. See Appendix D for a breakdown of the dependent variables used in this study.

Computer analysis. All samples were submitted to Coh-Metrix using the procedures outlined in Experiment 1. For productivity measures, writing samples were also submitted to SALT. Productivity scores allowed for the examination of other changes in writing that co-occurred with changes in cohesion. These measures included the number of words and T-

Units written in 15 minutes, the mean length of T-units (a syntactic measure), and the number of different words (a lexical measure).

Hand scoring. In addition to the cohesion scores generated by Coh-Metrix, the writing samples were also hand coded for the types of devices used, the mean distance between devices, and any ambiguities. A detailed description of the hand scoring procedures is presented in Appendix G. The scores for the types of devices used consisted of tallies of specific exemplars of reference (pronouns and demonstratives), conjunction (additive, temporal, causal, and adversative), and lexical cohesion (repetition, synonyms/near synonyms, and collocation). Tallies from both stories were combined to form an overall total for each time period. The total from each category was then converted to a proportional score per number of T-units to control for text length. To calculate mean distance, the number and distance of each mediated and remote tie was recorded for the two writing samples combined. The total distance was then divided by the number of mediated and remote ties. This value was then converted to a proportional score per number of T-units to control for text length. As well, the number of cohesive devices used ambiguously in the two stories was recorded, and also converted to a proportional per T-unit score. To illustrate the process, an example of a coded writing sample, is presented in Appendix H.

Coding reliability. I and another trained rater hand coded the writing samples. Training for the second rater consisted of background reading on the method, followed by practice sessions in finding and classifying cohesive devices by type. Once the second rater was able to identify and classify cohesive markers, we practiced coding devices by type and distance for 20 writing samples. During this process, we clarified coding procedures and recorded the clarifications in the scoring manual. By the end of this procedure, we agreed on

coding an average of 80% of the time. Each of the stories written for the pre-, mid-, and post-treatment assessments was then scored by both raters[7]. Ratings were then compared and we discussed disagreements until consensus was established. It should be noted that the majority of disagreements were the result of rater error rather than judgement differences.

Analysis

To determine if there were between group differences on cohesion measures at the three time points of the experiment, a 3 (condition: semantic, syntactic, control) by 3 (time: pre-, mid-, post-) repeated measures multivariate analysis of variance (MANOVA) was conducted. In this analysis, time was the within subject variable, condition was the between subjects variable, and four cohesion measures (ANA, CON, LSA, mean distance) were the dependent variables (DVs). Planned comparisons using a series of ANOVAs followed by post hoc tests were used to tease out the differential effects of the treatment conditions on each DV. Additionally, where effects were found, follow up ANOVAs and post hoc analyses were conducted using the detailed hand generated cohesion scores. Collectively, these analyses addressed the question of whether or not there was an effect for semantics or syntax treatments on cohesion measures.

If cohesion is an emergent property of semantics and/or syntactic oral language skills, I expected main effects for condition and time such that cohesion scores would differ by treatment and would change with time. Furthermore, I predicted that the semantic group would have higher lexical cohesion scores, the syntax group would have higher conjunctive cohesion scores, and that both groups would have better cohesion scores overall as compared to the control group. Additionally, I predicted an interaction between time and group, such

[7] Both raters scored all samples, as it was noted during scoring practice that one deviation in coding in one part of a cohesive chain could affect the rest of the scoring for that chain, resulting in multiple disagreements within a given writing sample.

that the treatment groups would show changes in cohesion scores across assessment times while the control group would remain relatively stable. Furthermore, cohesion scores might vary by time and group, such that each treatment group might have a unique pattern of cohesion use across times. Finally, if cohesion is not an emergent property of syntax and/or semantics, but simply a product of writing practice, I expected to find a main effect for time but no effect for group and no interaction. The investigation of the impact of condition on distance and anaphoric reference is exploratory.

CHAPTER 4

Results

Experiment 1

Seventy-seven participants completed the oral language and writing assessments in Experiment 1. Two participants were removed from the data set due to their performance on the writing task; one participant wrote only one of the two stories and the other wrote a series of sound effects and random words. The remaining 75 participants' scores were included in the initial data set.

Data Screening and Cleaning

Before running the regression analysis, the data were screened, beginning with the predictor variables. The semantic variable (SEM) was generated from the combined PPVT and word association scores. According to the Grade 4 PPVT-4 norms, an average score range of 133 (16th percentile) to 171 (84th percentile) would be expected for this grade level (Dunn & Dunn, 2007). In this sample, PPVT scores ranged from 95 to 203 with a median of 154 (M = 153, SD = 13.79), which would convert to a standard score of 101. For the other semantic measure, word associations, scores ranged from 32 to 84 with a median of 61 (M = 60.25, SD = 11.62).

The syntax variable (SYN) was initially generated by the combined scores from the Formulated Sentences of the CELF-4 and sentence generation tasks. Due to the planned administration and scoring modifications, noted in the Methods chapter, Formulated Sentences scores could not be compared to test norms. Additionally, it should be noted, that for this age group, there were only 21 items administered making the highest possible score 42. For this group, Formulated Sentences scores ranged from 0 to 39 with a median of 27 (M

= 25.61, *SD* = 8.60). The values generated for the sentence generation task were calculated following the formula developed by Justice et al. (2006). In their study, the mean score for their sample, which included children in Kindergarten through Grade 6, was 0.00, *SD* = 1.0. The mean for Grade 4 was 0.37, *SD* = 0.99. In this study, sentence generation scores ranged from -4.09 to 1.64 with a median of -1.95 (*M* = -1.86, *SD* = 0.97). The lower mean found in this study was likely due to the task differences. Whereas Justice et al. elicited language through oral narratives, I elicited multiple single sentences, which may have, in some way, constrained the verbal output. Indeed, in this sample, many of the sentences were short, simple constructions, whereas constructions used in telling a story may have been more elaborated.

All of the values found on these language measures fell within plausible ranges and were therefore judged to be reliable. As well, there were no effects for order of task presentation on either of these variables; for SEM, $t(73) = 0.87$, $p = .39$ and for SYN, $t(73) = 0.58$, $p = .57$.

Next, the data were examined for the presence of outliers. Scores greater than 2.5 *SD*s from the mean were considered to be univariate outliers (Stevens, 1996). Using this criterion, four participants were found to have outlying language scores. One had an extremely high PPVT ($z = 3.63$) resulting in a high SEM score ($z = 3.23$). Another had extremely low PPVT ($z = -4.21$) and SEM scores ($z = 3.15$). In both cases the PPVT scores for these participants were outside of the expected range according to test norms. A third participant scored 0 on Formulated Sentences, resulting in an outlying total syntax score (SYN; $z = -2.68$). This score is also unexpected for a student in Grade 4. Finally, one other participant had an extremely high score on sentence generation ($z = 3.62$). Given the discrepancies of these

participant's scores, they were felt to be nonrepresentative of the sample, and were subsequently removed from the data set. Descriptive statistics for the predictor variables, following removal of outlying cases, are presented in Table 6. As can be seen from examining the table, the distribution for SEM was leptokurtic, with most scores clustering around the mean. The distribution for SYN, however was negatively skewed and platykurtic with scores distributed across a larger range, and piled up on the high end of the distribution, probably owing to the ceiling effect of the Formulated Sentences subtest. Sentence generation scores, on the other hand, were more normally distributed.

To examine for the presence of multivariate outliers, Mahalanobis distances were calculated for the SEM, SYN, and combined IVs. Multivariate outliers were defined by Mahalanobis distances greater than $\chi^2 = 13.82$ ($p = .001$). After removal of the univariate outliers, there were no multivariate outliers in the remaining data. I next examined variables for normality, linearity, and homoscedasticity. Although skewness and kurotis for most variables deviated from 0 - z scores fell between -1.59 and .77 - regression analysis is robust to mild to moderate deviations from normality such as was found here (Tabachnick & Fidell, 2007). Additionally, no violations for linearity, or homoscedasticity were found. Correlations between the predictor variables of SYN and SEM were significant but small, $r(71) = .252$, $p = .034$, indicating that there were no issues for singularity or multicollinearity (defined as r approaching 0.9; Tabachnick & Fidell, 2007).

As the independent measures in this study were intended to differentially capture semantic and syntax abilities, I also examined Pearson's correlations for each pair of predictor variables. These correlations are presented in Table 7. Scores from the PPVT and word associations were significantly and positively related to each other and SEM, but not

any of the syntax measures. Conversely, Formulated Sentences and sentence generation scores were not related, and Formulated Sentences accounted for almost all of the variance of the SYN variable. Furthermore, Formulated Sentences, and consequently SYN, showed a small, but significant correlation to SEM. Given the shared variance between Formulated Sentences and the semantic variable, as well as its skewed distribution, this measure was removed from the analysis. If Formulated Sentences had been included in the SYN score, the effects for SYN would be less clear, due to the shared variance with semantics. As a result, SEM was the total of the combined PPVT and word association scores, and SYN consisted of the sentence generation score. Despite the change in the make-up of this score, I retained the name (SYN) as the new score reflected the same theoretical construct.

Next I screened the dependent variables using the procedures above. However, in this case, participants with cohesion scores greater than 2.5 *SD*s from the mean were excluded case-wise from the respective regression analysis. Anaphor overlap scores (ANA) ranged from 0.25 to 1.47 with a median of 0.80 ($M = 0.81$, $SD = 0.24$). The LSA scores ranged from 0.11 to 0.73 with a median of 0.32 ($M = 0.32$, $SD = 0.10$). The incidence of connectives (CON) ranged from 153 to 412 with a median of 275 ($M = 275$, $SD = 57.7$). There was one univariate outlier for ANA ($z = 2.77$) and one for LSA ($z = 4.05$). The participants with these scores were excluded from the ANA and LSA regression analyses, respectively. Resulting descriptive statistics for each of the cohesion measures are presented in Table 6.

Multivariate outliers for the three DVs were defined by Mahalanobis distances greater than $\chi^2 = 16.27$ ($p = .001$). No multivariate outliers were found. Some small nonsignificant deviations from 0 were found for both skewness and kurtosis for the three DVs, with z scores between -0.88 and 0.73; however, the analyses used in this study are

robust to these small deviations from normality (Tabachnick & Fidell, 2007). Additionally, no violations for linearity or homoscedasticity were found. Finally, I also checked for effects for the order of video presentation and found none for any of the Coh-Metrix measures; for ANA, $t(73) = 1.48, p = .14$; for LSA $t(73) = -1.39, p = .17$; and for CON, $t(73) = 0.76, p = .45$.

Regression Analyses

Results of the regression analysis are presented in Table 8. I expected that SYN would predict CON and SEM would predict LSA. Contrary to the first prediction, SYN did not predict CON; instead there was a significant predictive relationship between CON and SEM, accounting for 15.4% of the variance in CON. However, it should be noted that the direction of this relationship was negative, such that higher SEM scores were associated with lower CON scores.

In regards to the second prediction, SEM did not predict LSA; however there was a small nonsignificant predictive relationship of SYN for LSA. Again, this relationship was negative, such that higher SYN scores were associated with lower LSA scores. There was no predictive relationship of SEM or SYN for ANA.

One interpretation of these findings is that the effect for semantic and syntactic skills on cohesion is inhibitory rather than facilitatory. That is, better semantic skills may result in inhibition of conjunction use due to a tendency toward semantic processing. Conversely, better syntax skills may inhibit lexical cohesion due to a tendency toward syntactic processing. Rather than facilitating types of cohesion, language strengths may cause writers to ignore cohesive devices that do not relate to their area of language strength.

Table 6

Descriptive Statistics for Oral Language and Written Cohesion Scores Following Removal of Outliers

Measure	*M*	*SD*	Min	Max	Skewness	Kurtosis
			Oral Semantics Measures			
PPVT	153.55	10.20	127	178	-.22	.39
WA	60.00	11.65	32	84	-.13	-.32
SEM	213.55	17.62	166	259	-.09	.31
			Oral Syntax Measures			
FS	25.82	8.19	7	39	-.43	-.75
SG	-1.94	0.87	-4.09	0.27	.02	.13
SYN	23.88	8.38	4.79	36.73	-.45	-.76
			Written Cohesion Measures			
ANA	0.80	0.22	0.25	1.30	-.16	-.18
LSA	0.31	0.09	0.11	0.57	.21	-.06
CON	277	58.34	153	412	.11	-.50

Note. Min = minimum value; Max = maximum value; PPVT = Peabody Picture Vocabulary Test; WA = word associations; SEM = PPVT + WA; FS = Formulated Sentences; SG = sentence generation; SYN = FS + SG; ANA = Anaphor overlap (adjacent sentences); LSA = Latent Semantic Analysis (adjacent sentences); CON = incidence of connectives.

Table 7

Pearson's Correlations among Predictor Variables

	PPVT	WA	SEM	FS	SG
	r (*p*)	*r* (*p*)	*r* (*p*)	*r* (*p*)	*r* (*p*)
WA	.30 (.012)				
SEM	.78 (.000)	.83 (.000)			
FS	.18 (.134)	.22 (.067)	.25 (.037)		
SG	.03 (.781)	.11 (.362)	.09 (.445)	.17 (.160)	
SYN	.18 (.135)	.22 (.059)	.25 (.034)	.99 (.000)	.27 (.024)

Note. PPVT = Peabody Picture Vocabulary Test; WA = word associations; SEM = total semantic score (PPVT + WA); FS = Formulated Sentences; SG = sentence generation; SYN = total syntax score (FS + SG; prior to the removal of FS). In the upcoming regression, SYN consisted of only SG. See page 69 for the explanation.

In order to more closely examine these relationships between semantics and syntax skills and the differential use of cohesion, in Experiment 2, I conducted a microgenetic experiment in which oral syntax and semantics were differentially manipulated, and the effects on cohesion were examined at three different time points.

Experiment 2

Of the 45 participants who started the study, three withdrew following the midpoint. Two of these participants indicated that they liked being in the study but did not wish to continue as they no longer wanted to miss activities occurring in the classroom. Both had completed the midtreatment assessment prior to their withdrawal, and data from their pre- and midtreatment measures were retained. The third participant to withdraw did so after an extended absence from school. This participant did not complete the midtreatment assessment so was subsequently removed from the data set. All three withdrawing participants were from the control condition. Two of the participants were from the same school.

In addition to the withdrawing participants, five participants were absent on the day of the midtreatment writing assessment. This resulted in a total of 39 students (13 in each condition) completing the midtreatment assessment. Another three students also missed the posttreatment assessment. I returned to the school to collect writing samples from the three missing participants on two separate occasions in the week following the completion of the study; however, one student had moved away, and the other two were absent on both occasions. No further attempt was made to complete the final assessment, as I felt that too much time would have elapsed between the treatment and the posttest. Furthermore, the schools had no information as to when the students would be returning. Consequently only

39 students (14 for each treatment condition and 11 from the control condition) completed the posttreatment assessment. Writing samples from pretreatment, midtreatment, and posttreatment were computer and hand scored for cohesion, and submitted for analysis in this experiment.

Data Screening and Cleaning

Following computer and hand scoring of the writing samples, grouped Coh-Metrix and hand generated cohesion scores were screened for univariate outliers using the same criteria as Experiment 1. Due to the small sample size, univariate outliers were imputed rather than discarded (Field, 2013). One way of transforming a variable is to assign a value to the outlier that is 1 unit greater than the highest score for outliers with positive z scores or less than the lowest score for outliers with negative z scores (Tabachnick & Fidell, 2007). For all variables except CON, imputations consisted of redefining the outlying value using a unit of 0.1. This value was chosen as the means for these dependent variables had small values (< 5). Imputations for CON involved redefining the variable as 1.0 unit greater than the highest score or less than the lowest score.

For Coh-Metrix scores, I found two univariate outliers for CON ($z = 2.81$ and $z = 2.71$), one each in the mid- and posttreatment assessment for the same participant from the syntax condition. There were no significant multivariate outliers ($\chi^2 > 18.47, p = .001$). No linearity or normality issues were detected. Levene's test showed that the assumption for homogeneity of variance was met for all three variables across conditions ($p > .05$). Descriptive statistics for imputed ANA, LSA, and CON are presented in Table 9.

Table 8

Regression Analysis Results

Dependent Variable	Predictor Variable	Coefficient	*SE*	Standardized Coefficient	*t*	*p*
			$R^2 = .020$			
ANA	Constant	.441	.340		1.29	.200
N = 70	SEM	.002	.002	.138	1.14	.259
	SYN	.007	.031	.026	0.21	.832
			$R^2 = .066$			
LSA	Constant	.228	.130		2.29	.085
N = 70	SEM	.000	.001	.028	0.07	.813
	SYN	-.026	.001	-.258	-0.01	.033
			$R^2 = .154$			
CON	Constant	543.39	82.08		6.62	.000
N = 71	SEM	-1.28	.37	-.385	-3.44	.001
	SYN	-3.15	7.50	-.047	-0.42	.676

Note. ANA = anaphoric overlap (adjacent sentences; LSA = Latent Semantic Analysis (adjacent sentences); CON = incidence of connectives; SEM = total semantic score (an aggregate of the PPVT and word association scores); SYN = syntax score (comprised of the sentence complexity score only).

Table 9

Descriptive Statistics for Coh-Metrix Scores by Time and Condition

	Cohesion Scores		
	ANA	LSA	CON
Condition	*M (SD)*	*M (SD)*	*M (SD)*
		Pretreatment	
Syntax	0.80 (0.24)	0.31 (0.08)	290 (48.60)
Semantic	0.73 (0.20)	0.31 (0.70)	279 (64.83)
Control	0.82 (0.22)	0.29 (0.10)	258 (43.63)
Total	0.78 (0.22)	0.30 (0.08)	276 (53.80)
		Midtreatment	
Syntax	0.95 (0.17)	0.35 (0.11)	248 (50.21)
Semantic	0.91 (0.36)	0.34 (0.12)	267 (44.07)
Control	0.87 (0.32)	0.41 (0.15)	271 (63.12)
Total	0.91 (0.29)	0.36 (0.13)	262 (52.61)
		Posttreatment	
Syntax	0.93 (0.27)	0.36 (0.08)	289 (53.93)
Semantic	0.89 (0.32)	0.36 (0.11)	264 (59.02)
Control	1.02 (0.41)	0.30 (0.06)	268 (77.34)
Total	0.94 (0.33)	0.34 (0.09)	274 (62.36)

Note. ANA = anaphor overlap (adjacent sentences); LSA = Latent Semantic Analysis (adjacent sentences); CON = incidence of connectives.

For the five hand-generated cohesion summary scores of mean distance, reference, lexical cohesion, conjunctions, and ambiguities, I found six outliers, which were subsequently imputed. Outliers included: two midtreatment reference scores, with one from each treatment group; one mid- and one posttreatment conjunction score from the same participant in the syntax condition that had the outlying CON scores; and two pretreatment lexical cohesion scores, one from each treatment condition. No multivariate outliers were found, $\chi^2 = 18.47$ ($p = .001$) and assumptions of normality were met for mean distance, reference, lexical cohesion, and conjunctions. However, the distribution of ambiguous ties was abnormal, as many participants had one or no ambiguities at each time period, with the cell means inflated by the few who had multiple ambiguities. This variable was subsequently dropped from further analysis. Levene's test for homogeneity of variances was conducted on all hand generated cohesion summary scores, with the exception of ambiguities. This assumption was met for all variables except lexical cohesion in the posttreatment assessment, $F(2, 36) = 4.697$, $p = .015$. Descriptive statistics for the five hand generated summary cohesion scores are reported in Table 10.

To screen the data for issues of multicollinearity and singularity, Pearson's correlations were calculated for pairs of cohesion scores, both ungrouped and grouped by assessment time. Correlations for the ungrouped and grouped data are reported in Table 11 and 12 respectively. There were significant moderate to strong relationships between Coh-Metrix and hand generated cohesion scores measuring the same types of cohesion (i.e. reference with ANA, conjunctions with CON, and lexical cohesion with LSA). These relationships were especially strong when comparing scores from the same testing period.

Consequently, these pairs of measures were not used together in any of the analyses as, if combined, they would present potential issues with multicollinearity and singularity.

There were no relationships among mean distance, ANA, and CON in the ungrouped data; however there was one significant correlation between mean distance and ANA for the posttreatment assessment. The LSA scores had small to medium significant negative correlations with mean distance and ANA, which arose from the pre- and midtreatment assessments. As these correlations were not large (i.e. they were not approaching $r = 0.9$), the assumptions for multicollinearity and singularity for this group of DVs were met.

Coarse-Grained Analyses

Following cleaning, the data were submitted to 3 (condition: syntax, semantics, control) by 3 (time: pre-, mid-, post-) by 4 (cohesion: ANA, LSA, CON, mean distance) repeated measures MANOVA. In this analysis condition was the between subjects variable, and cohesion scores at each time period were the within-subjects variables. I used Pillai's trace, which is robust to potential problems caused by small and unequal sample sizes, as well as violations of the assumption of homogeneity of variance-covariance (Tabachnick & Fidell, 2007). Using Pillai's trace, I found a significant main effect for cohesion, $V = 0.988$, $F(3, 29) = 783.79$, $p < .001$, $\eta_p^2 = .99$, with an observed power of > .99; and significant interactions for cohesion and time, $V = 0.595$, $F(6, 26) = 6.36$, $p < .001$, $\eta_p^2 = .60$, with an observed power of .99; and for cohesion by time by condition, $V = 0.618$, $F(12, 54) = 2.01$, $p = .04$, $\eta_p^2 = .31$, with an observed power of .87. However, contrary to my prediction, there was no main effect for condition, $F(2, 31) = .113$, $p = .894$, $\eta_p^2 = .007$, observed power .07.

Table 10

Descriptive Statistics for Hand Generated Cohesion Scores by Time and Condition

	Cohesion Scores				
Condition	Mean Distance *M (SD)*	Reference *M (SD)*	Conjunctions *M (SD)*	Lexical Cohesion *M (SD)*	Ambiguous Ties *M (SD)*
			Pretreatment		
Syntax	4.87 (1.12)	1.16 (0.19)	0.76 (0.19)	0.96 (0.29)	0.18 (0.12)
Semantic	4.60 (1.07)	1.15 (0.21)	0.83 (0.25)	1.01 (0.21)	0.17 (0.12)
Control	4.68 (1.28)	1.24 (0.19)	0.70 (0.19)	1.04 (0.24)	0.15 (0.12)
Total	4.71 (1.14)	1.18 (0.20)	0.77 (0.22)	1.00 (0.25)	0.17 (0.22)
			Midtreatment		
Syntax	4.39 (0.98)	1.18 (0.19)	0.64 (0.18)	1.18 (0.31)	0.12 (0.06)
Semantic	3.90 (0.93)	1.23 (0.20)	0.78 (0.19)	1.18 (0.47)	0.16 (0.05)
Control	4.62 (1.16)	1.22 (0.25)	0.78 (0.25)	1.39 (0.39)	0.15 (0.11)
Total	4.30 (1.04)	1.21 (0.21)	0.74 (0.21)	1.25 (0.40)	0.14 (0.08)
			Posttreatment		
Syntax	3.74 (0.52)	0.97 (0.25)	0.80 (0.20)	1.31 (0.29)	0.07 (0.04)
Semantic	3.75 (0.71)	1.02 (0.33)	0.75 (0.20)	1.23 (0.53)	0.12 (0.09)
Control	3.91 (0.41)	1.06 (0.16)	0.79 (0.31)	1.30 (0.29)	0.16 (0.10)
Total	3.79 (0.56)	1.01 (0.26)	0.78 (0.23)	1.28 (0.39)	0.11 (0.08)

Table 11

Correlations among Cohesion Variables Using Ungrouped Data

Cohesion Score	Ref	Conj	Lex	Distance	ANA	CON
	(*p*)	(*p*)	(*p*)	(*p*)	(*p*)	(*p*)
Conj	.113					
	(.214)					
Lex	-.348	-.084				
	(<.001)	(.357)				
Distance	.400	-.070	-.326			
	(<.001)	(.443)	(<.001)			
ANA	.504	.095	-.277	.168		
	(<.001)	(.295)	(.002)	(.064)		
CON	.072	.815	-.144	.002	.071	
	(.428)	(<.001)	(.122)	(.984)	(.435)	
LSA	-.157	.000	.566	-.297	-.288	-.017
	(.085)	(.997)	(<.001)	(.001)	(.001)	(.850)

Note. Ref = reference; Conj = conjunctions; Lex = lexical cohesion; Distance = mean distance; ANA = Anaphor overlap (adjacent sentences); CON = incidence of connectives; LSA = Latent Semantic Analysis (adjacent sentences).

To tease out the effects for time, I conducted a separate repeated measures ANOVA for each of the dependent variables using time as a factor, followed by planned comparisons. The results of this analysis are presented in Table 13. I found a significant difference for mean distance by time for the syntactic and control conditions, and a near significant change for the semantic condition. Another significant effect of time was found for LSA for the control group. Finally, there was also an effect for CON for the syntax condition.

Tests of within-subjects contrasts showed a significant change in mean distance from pre- to posttreatment for the syntax, $F(1, 11) = 14.04$, $MSE = 13.95$, $p = .003$, $\eta_p^2 = .56$, observed power = .83; semantic, $F(1, 11) = 5.07$, $MSE = 4.90$, $p = .046$, $\eta_p^2 = .32$, observed power = .54; and control conditions, $F(1, 9) = 9.40$, $MSE = 12.28$, $p = .013$, $\eta_p^2 = .51$, observed power = .78. Additionally, the syntax, $F(1, 11) = 4.76$, $MSE = 5.63$, $p = .052$, $\eta_p^2 = .30$, observed power = .51, and semantic conditions, $F(1, 11) = 3.84$, $MSE = 2.51$, $p = .076$, $\eta_p^2 = .26$, observed power = .43, showed a near-significant change between the pre- and midtreatment measures, but the control condition did not, $F(1, 9) = 0.11$, $MSE = 0.35$, $p = .74$, $\eta_p^2 = .01$, observed power = .06.

Simple planned comparisons also showed that the difference in LSA scores for the control group occurred between pre- and midtreatment, $F(1, 9) = 7.97$, $MSE = 0.12$, $p = .02$, $\eta_p^2 = .47$, observed power = .71, but not pre- and posttreatment $F(1, 9) = 1.18$, $MSE = 0.01$, $p = .31$, $\eta_p^2 = .12$, observed power = .16. The change for the control group consisted of an increase in LSA at midtreatment, followed by a decrease at posttreatment to near-baseline levels.

Table 12

Correlations for Cohesion Measures by Assessment Time

Time	Cohesion Score	Ref	Conj	Lex	Distance	ANA	CON
		(*p*)	(*p*)	(*p*)	(*p*)	(*p*)	(*p*)
Pre	Conj	.198					
N= 44		(<.001)					
	Lex	-.239	-.021				
		(.118)	(.890)				
	Distance	.357	-.232	-.207			
		(.017)	(.130)	(.177)			
	ANA	.493	-.195	-.343	.322		
		(.001)	(.204)	(.023)	(.033)		
	CON	.217	.725	-.095	-.172	.050	
		(.157)	(.000)	(.538)	(.265)	(.746)	
	LSA	.176	.081	.208	-.053	-.242	.025
		(. 253)	(.602)	(.175)	(.730)	(.113)	(.870)
Mid	Conj	.148					
N= 39		(.370)					
	Lex	-.423	-.239				
		(.007)	(.143)				
	Distance	.309	.113	-.415			
		(.056)	(.492)	(.009)			

Table 12 continues

Table 12 continued

Time	Cohesion Score	Ref (*p*)	Conj (*p*)	Lex (*p*)	Distance (*p*)	ANA (*p*)	CON (*p*)
Mid	ANA	.598	.054	-.518	.229		
N=39		(.000)	(.745)	(.001)	(.160)		
	CON	.092	.903	-.290	.101	.094	
		(.632)	(<.001)	(.148)	(.220)	(.862)	
	LSA	-.298	-.066	.731	-.523	-.518	-.039
		(.066)	(.688)	(<.001)	(.001)	(.001)	(.796)
Post	Conj	.107					
N = 39		(.518)					
	Lex	-.340	.008				
		(.034)	(.962)				
	Distance	.430	-.032	-.172			
		(.006)	(.845)	(.295)			
	ANA	.694	.350	-.348	.403		
		(<.001)	(.029)	(.030)	(.011)		
	CON	.024	.850	-.083	.014	.223	
		(.883)	(<.001)	(.616)	(.934)	(.172)	
	LSA	-.308	.047	.554	-.137	-.271	.047
		(.024)	(.775)	(<.001)	(.404)	(.095)	(.777)

Note. Ref = reference; Conj = conjunctions; Lex = lexical cohesion; Distance = mean distance

The final effect examined through planned comparisons was the effect of time on CON for the syntax group. I found a significant change from pre- to midtreatment, $F(1, 11) = 9.40$, $MSE = 28561$, $p = .011$, $\eta_p^2 = .46$, observed power = .80, but not from pre- to posttreatment, $F(1, 11) = 0.04$, $MSE = 164.72$, $p = .85$, $\eta_p^2 = .003$, observed power = .05. The changes in scores in this condition, reflected a sharp decrease in the number of conjunctions used in the midtreatment assessment, followed by a return to near-baseline level in the posttreatment assessment.

Despite the lack of main effect for condition, there was an interaction between time, condition, and cohesion, suggesting that differences in cohesion by time may not be the same across groups. As can be seen in Figure 2 the trends for change over time for each cohesion score looked different by condition. In three of the cases – mean distance, ANA, and LSA – the trends for change in the syntax and semantic groups looked similar in size and direction, but appeared different than the path of the control group. This difference was most noticeable for LSA (Figure 2c). Additionally, the pattern for CON for the syntax condition (Figure 2d) looked quite different from that of the semantic and control conditions. As variability from one time to the next is considered an interesting and meaningful component of developmental change (Flynn & Siegler, 2007; van Dijk & van Greet, 2007), further exploration of the data seemed warranted. To examine these significant findings and group differences more closely, I turned to analyses of the detailed hand generated cohesion scores and computer generated productivity scores. Additionally, as some of the between group differences may have been diminished by the overlapping variance between the two treatment conditions, in the next analyses I separated the treatment groups and compared each in turn to the control condition.

Table 13

Changes in Cohesion Scores by Time

		Group Means by Time							
Cohesion	Cond	Pre-	Mid-	Post-	*F*	*df*	*MSE*	Sig.	η_p^2
Mean	Syn	4.87	4.39	3.74	7.63	2, 22	3.57	.003	.41
Dist.	Sem	4.60	3.90	3.75	3.28	2, 22	1.30	.057	.23
	Cont	4.68	4.62	3.91	3.59	2, 18	3.52	.049	.29
LSA	Syn	0.31	0.35	0.36	1.07	2, 22	0.01	.323	.09
	Sem	0.31	0.34	0.36	0.71	2, 22	0.01	.504	.06
	Cont	0.29	0.41	0.30	4.48	2, 18	0.03	.021	.35
CON	Syn	290	248	289	5.24	2, 22	8852	.014	.32
	Sem	279	267	264	0.02	2, 22	26.31	.984	.05
	Cont	258	271	268	0.37	2, 18	731	.699	.04

Note. Cond = condition; Sig. = significance; Mean Dist. = mean distance; LSA = Latent Semantic Analysis (adjacent sentences); CON = Incidence of connectives; Syn = syntax condition; Sem = Semantic condition; Cont = control condition.

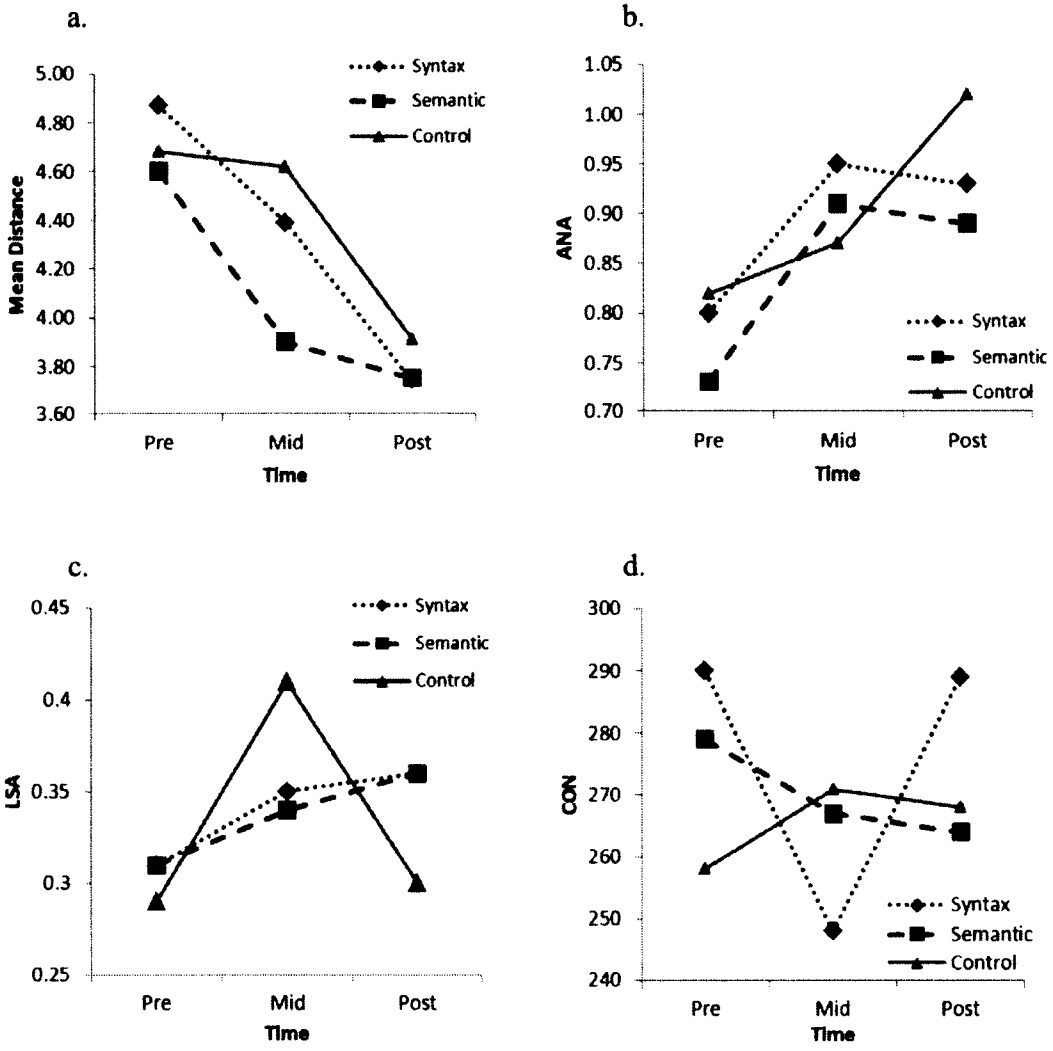

Figure 2. Comparison of mean scores for dependent variables at each assessment time.

Fine-Grained Analyses

Data screening and cleaning. Prior to running the additional analyses, I examined the variables of interest for outliers as well as issues with normality, linearity, and homogeneity. The cohesion variables included in this screening were incidence scores for pronouns and demonstratives (which together made up the reference score); repetition, use of synonyms/near synonyms, and collocation (which collectively made up the lexical cohesion score); and coordinated conjunctions (which consisted of the total of additive and coordinating temporal conjunctions), subordinating temporal conjunctions, adverbials, causal conjunctions, and adversative conjunctions (which collectively made up the conjunction score). Inspection of the scores showed that causal conjunctions were used rarely by any of the participants, so were not considered for further analysis. Productivity scores included number of T-units, total number of words written, mean length of T-units (MLTU), and the number of different words (NDW).

As with previous analyses, scores greater than 2.5 *SD*s from the mean were considered outliers, and subsequently imputed by creating a new score that was 0.1 units greater than the highest score or less than the lowest score. This process resulted in a total of 14 imputations: two for pronouns, three for lexical repetition, one for collocation, two for co-ordinated conjunctions (both from the same participant who had outlying CON scores), three for subordinating conjunctions, one for adverbials, one for adversative conjunctions, and one for NDW.

For the cohesion scores, skewness values for all variables except one fell within tolerable limits ($-3.0 > z < 3.0$). The distribution of subordinating temporal conjunctions were noticeably leptokurtic for the syntax condition at midtreatment ($z = 3.31$). As the assumption

of normality for this variable was not met, it was subsequently removed from further analysis. For the productivity scores, only one variable, MLTU for the syntax condition in the posttreatment assessment, had skewness and kurtosis values outside of tolerable ranges. This variable was also removed from further analysis. Additionally, NDW and total number of words were strongly correlated, $r(122) = .95, p < .001$, so total number of words was not included the analysis of productivity, as its inclusion would have resulted in issues for multicollinearity. Consequently, only the number of T-units and NDW were used in the analyses for productivity.

Levene's tests for homogeneity of variance were also conducted for the lexical cohesion measures of the semantic and control groups, the conjunction measures of the syntax and control groups, and the productivity measures of all three groups. For the lexical measures, only repetition in the final assessment period did not meet the assumption of homogeneity, $F(1,23) = 5.43, p = 0.29$. To accommodate for this violation, the robust Brown-Forsythe F was used when comparing groups for differences (Field, 2013). All other detailed cohesion and productivity measures satisfied the assumption for homogeneity ($p > .05$).

Reference. First, bivariate Pearson's r correlations were run comparing the detailed reference scores against other cohesion measures to explore the relationship between ANA and other types of cohesion. Pronoun use was significantly and negatively related with lexical repetition, $r(122) = -.627, p < .001$, and synonym use, $r(122) = -.214, p = .018$, suggesting that children who rely on lexical devices use fewer pronoun reference ties. Conversely, demonstratives were positively related to repetition, $r(122) = .286, p = .001$.

Additionally, these variables were negatively related to one another, $r(122) = -.321, p < .001$. No relationships were found between reference types and any of the conjunction variables.

Lexical cohesion. To determine what changes may have accounted for the differences for LSA between the semantic and control conditions, I examine the repetition, synonym/near synonym, and collocation variables for these two groups. Descriptive statistics for each lexical cohesion measure by group and time are reported in Table 14. As can be seen from examining this table, both groups showed an increase in repetition from pre- to midtreatment, followed by a decrease between mid- and posttreatment; however, the increase for repetition in the control condition was double that of the semantic condition. Additionally, both groups showed limited use of synonyms/near synonyms; although the semantic group showed a small increase, while the control group showed little, if any change in this variable over time. Finally, both groups showed increases in collocation over time, with the control condition showing higher scores in collocation at each time period, including baseline.

First, to determine which lexical devices may have accounted for the apparent differences between the two groups for LSA at midtreatment, I ran separate one-way ANOVAs comparing the two groups on each of the three lexical cohesion measures for this time. In each analysis, either repetition, synonyms/near synonyms, or collocation was the within subjects variable, and condition was the between subjects factor. I found a significant between groups effect for synonyms/near synonyms, $F(1, 23) = 5.18, p = .032$, related to higher use of these devices by the control condition at this time. There were no significant between groups difference for the other two lexical cohesion measures.

Table 14

Descriptive Statistics for Hand Generated Lexical Cohesion Scores by Time and Condition

	Subtypes of Lexical Cohesion		
		Synonyms &	
	Repetition	Near synonyms	Collocation
Time	*M (SD)*	*M (SD)*	*M (SD)*
	Semantic Condition		
Pre	0.80 (0.13)	0.04 (0.04)	0.13 (0.06)
Mid	0.91 (0.49)	0.02 (0.03)	0.26 (0.08)
Post	0.77 (0.45)	0.08 (0.05)	0.27 (0.09)
	Control Condition		
Pre	0.82 (0.23)	0.05 (0.05)	0.19 (0.08)
Mid	1.08 (0.41)	0.06 (0.06)	0.27 (0.10)
Post	0.99 (0.25)	0.07 (0.06)	0.33 (0.09)

Next, I examined both groups for the changes in lexical cohesion over time. I conducted separate repeated measures ANOVAs for each of the lexical cohesion variables using time as a factor, followed by planned comparisons. Where the assumption of sphericity was not met, I used a Greenhouse-Geisser *F* to correct for the violation (Field, 2013). In these analyses, I found no effect of time for repetition for either the semantic, Greenhouse-Geisser $F(1.32, 14.48) = 0.41$, $MSE = 0.1$, $p = .59$, $\eta_p^2 = .04$, observed power = .10, or the control group, $F(2, 18) = 2.32$, $MSE = 0.17$, $p = .85$, $\eta_p^2 = .21$, observed power = .41. However, there was a significant effect of time for synonym/near synonyms for the semantic condition, $F(2, 22) = 4.19$, $MSE = 0.01$, $p = .029$, $\eta_p^2 = .28$, observed power = .67. Pairwise comparisons using a Bonferroni adjustment confirmed that the significant difference lie between the mid- and posttreatment measures, $M_{diff} = 0.06$, $SE = 0.02$, $p = 0.025$, with the semantic condition showing growth in synonym/near synonym use at this time.

Finally, there was also a significant change in collocation for both the semantic, $F(2, 22) = 9.58$, $MSE = 0.07$, $p = .001$, $\eta_p^2 = .47$, observed power = .96, and control groups, $F(2, 18) = 5.74$, $MSE = 0.05$, $p = .012$, $\eta_p^2 = .39$, observed power = .80. Pairwise comparisons using a Bonferroni adjustment showed significant differences for the semantic group between pre- and midtreatment, $M_{diff} = 0.13$, $SE = 0.04$, $p = .012$, as well as pre- and posttreatment, $M_{diff} = 0.14$, $SE = 0.04$, $p = 0.01$; whereas the control group only showed a significant increase between pre- and posttreatment, $M_{diff} = 0.14$, $SE = 0.04$, $p = .033$. This finding shows that although both groups showed increases in collocation, the significant change for the semantic group came earlier.

Given these findings, the midtreatment increase in LSA for the control group may be explained by the combined nonsignificant increases in lexical repetition and collocation.

Even though the semantic group also saw increases in these variables, the increase in repetition was smaller. Although the increase in collocation for the semantic group was larger than that of the control group, LSA was positively and significantly related to lexical repetition, $r(122) = .589$, $p < .001$, but not collocation, $r(122) = .154$, $p < .09$. Thus, the change in repetition would account for more of the change in LSA.

Additionally, despite the nonsignificant effect of condition for LSA, there appeared to be some differences between the groups in terms of changes made in lexical cohesion over time. That is, only the semantic group showed a significant increase in synonym/near synonym use with time. Additionally, although both groups saw an increase collocation, the change occurred earlier for the semantic group.

Conjunctions. Next, to determine what changes may have accounted for the differences for conjunction use between the syntax and control conditions, I examined the coordinated, adverbial, and adversative conjunction variables for these two groups. In particular, I was interested in what changes in conjunctions may have accounted for the drop at midtreatment for CON. Descriptive statistics for conjunction scores for these two groups are presented in Table 15.

As apparent differences in CON between the syntax and control groups appeared at all three assessment times, I first ran three separate one-way ANOVAs, comparing the two groups at each time period, on conjunction scores. The only significant finding was a between groups difference for adverbials at posttreatment, $F(1, 24) = 17.35$, $MSE = 0.04$, $p < .001$, with the control group using more of these devices at this time. No other significant between group differences were found at any of the other times, for any of the other conjunction variables.

Table 15

Descriptive Statistics for Hand Generated Conjunction Scores by Time and Condition

	Subtypes of Conjunctions			
	Coord	Subord	Adverb	Adverse
Time	*M (SD)*	*M (SD)*	*M (SD)*	*M (SD)*
		Syntax Condition		
Pre	0.53 (0.18)	0.06 (0.04)	0.06 (0.06)	0.11 (0.06)
Mid	0.37 (0.18)	0.07 (0.07)	0.05 (0.06)	0.12 (0.04)
Post	0.49 (0.17)	0.09 (0.07)	0.04 (0.05)	0.10 (0.05)
		Control Condition		
Pre	0.40 (0.17)	0.09 (0.06)	0.06 (0.05)	0.12 (0.07)
Mid	0.39 (0.25)	0.10 (0.07)	0.09 (0.05)	0.11 (0.06)
Post	0.46 (0.31)	0.12 (0.06)	0.12 (0.06)	0.08 (0.05)

Note. Cond = condition; Coord = coordinating conjunctions; Adverb = adverbials; Adverse = adversative conjunctions; Subord = subordinating temporal conjunctions.

Next, to examine the change by time, I conducted a separate repeated measures ANOVA for each conjunction type with time as a factor, followed by planned comparisons. The assumption for sphericity was met in all cases. The only statistically significant change in conjunction use over time was for coordinated conjunctions in the syntax condition, $F(2, 24) = 3.98$, $MSE = 0.09$, $p = .032$, $\eta_p^2 = .25$, observed power = .66. Follow-up pairwise comparisons using a Bonferroni adjustment showed that a significant drop in coordinated conjunctions occurred between the pre- and midtreatment measures, $M_{diff} = -0.16$, $SE = .05$. $p = .015$.

It should be noted that the control group also showed a near-significant change in the use of adverbials by time, $F(2, 18) = 3.33$, $MSE = 0.01$, $p = .059$, $\eta_p^2 = .27$, observed power = .56. Follow-up pairwise comparisons using a Bonferroni adjustment showed that the increase of note was between the pre- and posttreatment use of adverbials, $M_{diff} = 0.07$, $SE = .02$. $p = .061$. It would appear that the control group showed a small, albeit nonsignificant, steady growth in the use of adverbials over time.

These findings help to explain the midtreatment decrease in CON seen in the coarse grained analysis. As coordinated conjunction use correlated strongly with CON at this time period, $r(39) = .79$, $p = .001$, it would appear that the drop was related primarily to a reduction in the use of coordinated conjunctions.

Productivity. To determine whether differences in how much was written could account for the trends found in these follow-up analyses, I next examined the productivity scores. To determine if there were any differences in productivity between groups and times, I conducted a repeated measures factorial MANOVA with productivity (number of T-units and NDW) and time as the within subject factors and condition as the between subjects

factor, followed by planned comparisons. Using Pillai's trace, there was a significant main effect for productivity, $V = 969$, $F(1, 31) = 984.3$, $p < .001$, $\eta_p^2 = .97$, observed power >.99, and condition, $F(2, 31) = 5.16$, $p < .012$, $\eta_p^2 = .25$, observed power =.79, and an interaction between productivity and condition, $V = 281$, $F(2, 31) = 6.05$, $p = .006$, $\eta_p^2 = .28$, observed power = .85. Posthoc comparisons using a Dunnett t showed that, the difference in productivity was between the semantic and control conditions, $t(2) = -19.48$, $SE = 5.70$, $p = .008$, with the control group writing more than the semantic group. There was no significant effect for time suggesting that writing productivity changed very little from one time period to the next. Examination of the descriptive statistics presented in Table 16 show that the control condition had higher productivity scores than the other groups at each time period.

The higher productivity for the control group may explain the greater use of lexical repetition for the control group at midtreatment, and the subsequent increase in the LSA scores for that time. However, neither measure of productivity was positively related to repetition at this time period; $r(37) = .027$, $p = .872$ for the number of T-units, and $r(37) = .171$, $p = 0$ .313 for NDW. Likewise, neither number of T-units, $r(39) = -.157$, $p = .339$, nor NDW, $r(39) = .003$, $p = .987$, was related to midtreatment LSA. Furthermore, the control group did not show a significant difference in the amount written between pre- and midtreatment. Therefore, it would seem that the increase in LSA cannot be accounted for by changes in productivity.

Unlike the case for LSA, there was a decrease in NDW for the syntax group at midtreatment that may have accounted for the decrease in CON that occurred at this time. However, there were no significant differences between the syntax and control conditions for mean productivity, $t(2) = -6.39$, $SE = 6.27$, $p = .57$, and no effect for time on productivity

measures. I did find a significant correlation between NDW and the use of coordinating conjunctions at midtreatment, $r(37) = -.40$, $p = .013$, but in a negative direction, so a decrease in NDW should be accompanied by an increase in coordinating conjunctions, which was not the case. Additionally, NDW was not related to CON at this time period, $r(39) = -.16$, $p = 0.34$. Thus, the decrease in CON scores in the midtreatment assessment cannot be explained by a decrease in productivity.

Summary of Findings

In Experiment 1, I found that semantic scores predicted lower CON scores, and that syntax scores had a small negative relationship to LSA scores. In Experiment 2, I did not find the expected effect for condition, but found dissimilarities in the way children in the different conditions changed in their mean distance between ties, and their use of lexical and conjunction devices over time. I will elaborate on these findings in the next chapter.

Table 16

Descriptive Statistics for Productivity Scores by Time and Condition

	Productivity	
	No. of T-units	No. of Different Words
Time	*M (SD)*	*M (SD)*
	Syntax Condition	
Pre	35.58 (13.71)	134.17 (23.41)
Mid	33.58 (11.34)	122.58 (31.02)
Post	30.83 (8.93)	121.50 (32.94)
	Semantic Condition	
Pre	29.33 (11.02)	115.33 (35.05)
Mid	25.67 (11.06)	101.50 (30.65)
Post	25.58 (9.19)	102.33 (23.23)
	Control Condition	
Pre	34.00 (6.52)	140.80 (29.23)
Mid	35.30 (7.82)	139.30 (20.93)
Post	31.60 (7.31)	135.60 (18.72)

CHAPTER 5

Discussion

In this study, I examined the contributions of semantics and syntax to the development of cohesion in the writing of children in Grade 4 in two different experiments. In this chapter, I will discuss the results of these experiments, by first addressing the three questions guiding this research, and then elaborating on the contributions of these findings to our understanding of the development of cohesion, text generation, and dual coding theory. I will also discuss the limitations of this study, and the implications for practice and future research.

Relationships among Semantics, Syntax, and Cohesion

The first research question addressed the relationship between semantic and syntactic components of language and the development of cohesion in the writing of children. The first attempt to address this question came from the regression analysis in Experiment 1. I expected that measures of oral language would predict measures of cohesion. More specifically, I expected that children with rich semantic representations and processes would score high on measures of breadth (PPVT) and depth of vocabulary (word associations), and would tend to process semantically. This tendency toward semantic processing would result in greater use of collocation and synonym/near synonym use, which would consequently result in higher LSA scores. Similarly, I expected that children with strong hierarchically arranged connections among verbal representations and strong sequential processing within the verbal system would score higher on the measure of syntactic complexity in a sentence generation task, and would tend to process syntactically. This tendency toward syntactic processing would result in greater use of conjunctions to form complex sentences, and thus a

high incidence of connectives. As the relationship of semantic and syntactic processing to reference devices is not clear, I had no predictions for anaphor overlap. However, I included this variable in the analysis because it is an important aspect of cohesion. Given the semantic and syntactic arguments about the origin of cohesion, I was interested to see if anaphor overlap would also be predicted by semantics, syntax, or both.

The results of the regression analysis were mixed. Although I did find a predictive relationship of semantic skills to cohesion, instead of predicting LSA, they predicted the incidence of connectives. Less surprisingly, the direction of this relationship was negative; that is, higher scores for depth and breadth of vocabulary were related to a lower incidence of connectives.

One possible explanation for this finding is that children with strong semantic abilities have a tendency to rely less on syntactic processing. Rather than having a facilitatory effect, the tendency to process semantically may therefore inhibit syntactic processing. According to connectionist frameworks, cognitive processing is based on spreading activation involving both excitatory and inhibitory connections across a network (McLeod et al., 1998; Sadoski & Paivio, 2013). The outcome of any processing is based on the number and strength of connections, and these connections are competing (Sadoski & Paivio, 2013). Individuals with comparatively stronger nonverbal representations may therefore have a tendency toward semantic processing, such that the referential processing between words and their associated imagens outweighs the associative processing among words and phrase structures within the verbal system.

No other significant predictive relationships were found in the regression analysis; that is, syntax did not predict the incidence of connectives as expected. However, there was a

small relationship of syntax to LSA. Like the relationship for semantics and connectives, the direction of this relationship was negative, such that higher syntax scores were associated with lower LSA scores. This finding suggests that stronger syntactic ability, and a possible tendency to process syntactically, may lead to some degree of inhibition for semantic processing due to competition from strong sequential associative connections in the verbal system. The result of this competition could be a depression of LSA scores. However, given the nonsignificant finding for the regression, this hypothesis requires further investigation.

Language scores did not predict anaphor overlap, and anaphor overlap did not relate to either of the language measures. This finding would suggest that facility with semantics and syntax has no bearing on the use of reference devices; however, anaphor overlap measured pronoun use, but not demonstratives, so did not provide a full account for reference. Furthermore, during the fine-grained analysis in Experiment 2, I found that the relationship of pronoun use to lexical retieration was strongly negative and that pronoun and demonstrative use were negatively related to one another. Given these relationships, it would appear that reference may in fact tap into two different underlying skills. As demonstrative use was associated with lexical cohesion, it may be based on a clear referent in the nonverbal mental model, and thus be related to semantic abilities. Conversely, pronoun use may be more related to morphological development, which was not investigated in this study.

Another possible origin for reference ties is pragmatic abilities (Schneider & Hayward, 2010). Schneider and Hayward argue that because children master oral pronoun use early in development, ambiguous use of pronouns cannot be accounted for by poor grammatical skill. Instead, they argue that reference devices may be more related to the writer's ability to keep their reader in mind. In keeping with this argument, de Villiers (2004)

used ambiguous reference connections as an indicator of poor pragmatic ability. However, ambiguous use of reference ties was more likely for children with language impairments, than for same age peers without, suggesting that some aspect of language must play a role in the appropriate use of reference devices. Unfortunately, de Villiers does not report which aspects of language were impaired for the children in this study. Consequently, which aspect of language processing supports unambiguous reference use remains unclear. If pronoun use is related to other aspects of language (i.e. morphology or pragmatics) or another mediating variable not measured in this study, the null finding for a predictive relationship of oral semantics and syntax for anaphor overlap would not be surprizing.

Cohesion as an Emergent Property of Semantics and Syntax

The second research question addressed whether or not cohesion is an emergent property of semantics, syntax, or both. The results of Experiment 1 suggested a stronger relationship between semantics and cohesion than syntax and cohesion; however, this relationship was inhibitory rather than facilitatory and only impacted the incidence of connectives. To more clearly examine cohesion as an emergent property of semantics or syntax, I conducted Experiment 2. If cohesion was an emergent property of both semantics and syntax, I predicted that there would be a main effect for condition. If cohesion is an emergent property of semantics, I expected that the cohesion scores for the semantic condition would differ from that of the syntactic and control groups. More specifically, given my original prediction and the results of the regression analysis, I expected the impact to be on LSA and the incidence of connectives. Conversely, if cohesion is an emergent property of syntax, I expected the syntax group to differ from the semantic and control groups, again, particularly on measures of LSA and the incidence of connectives.

In fact, I did not find any main effect for condition. That is, there was no overall consistent effect for treatment conditions on cohesion. All groups showed similar trends of decreasing mean distance and increasing anaphor overlap. For LSA, the control group showed increased scores at midtreatment followed by a return to baseline at posttreatment, while the treatment conditions performed similarly to one another, showing relatively little change in LSA over time. For the incidence of connectives, the syntax group showed a decrease at midtreatment followed by a return to baseline at posttreatment. Additionally, the connective scores differed, although not significantly, among groups at baseline. However the semantic and control groups were very similar in their use of conjunctions by midtreatment. Collectively, these patterns show no consistent difference by condition in the way cohesion appeared at each time period. That is, the groups performed similarly on some aspects of cohesion at some points in time, and differently on other aspects of cohesion at other points in time. Furthermore, with the exception of mean distance, when group differences existed, they did not reflect a consistent trend of increase or decrease in cohesion scores, thus resulting in no consistent effect for condition.

Another way to address this question was to look for an interaction between time and condition. I reasoned that if cohesion was an emergent property of semantics, cohesion scores would change for the semantic treatment group, whereas if cohesion was an emergent property of syntax, I would see cohesion scores change for the syntax group. I did not expect to see changes in cohesion for the control group. However, there was no interaction between time and condition. That is, no one group showed steady changes in all four measures of cohesion over time. Consequently, in Experiment 2 neither main effects nor interactions

revealed all aspects of cohesion to be an emergent property of one or the other of semantics or syntax.

Developmental Changes and Cohesion

The third question addressed the issue of how changes in the syntactic and semantic skills of children related to differences in the way they used cohesive devices in their writing. To answer this question, I looked for interactions among time, cohesion, and condition in Experiment 2. Given the results of previous analyses, I already knew that there was no effect for condition alone or in combination with time. However, if both semantics and syntax contributed something different to cohesion, changes in semantic processing could affect one type of cohesion and not another. Similarly, changes in syntactic processing could change yet another type of cohesion. More specifically, given the dual coding conceptualization of semantic and syntactic processes and representations, and the results of the regression analysis, I expected the semantic group would show increases in LSA and decreases in the incidence of connectives. At the same time, I expected the syntax group to show increases in connectives and no change or decreases for LSA.

A three way interaction did occur; however, the changes for the semantic group were not significant. That is, the semantic group showed score changes in the predicted direction, but the changes in LSA and the use of connectives from one time period to the next were small. Conversely, the syntax group did show significant changes in connectives; however, this change was due to a noticeable decrease in the use of connectives at midtreatment, running counter to my prediction. None the less, this pattern for the incidence of connectives across the three time periods was different than what was seen for the other two groups. Finally, the control group showed an unexpected significant change in LSA scores between

pre- and midtreatment, with the greatest difference in scores at this time existing between the semantic and control conditions.

To get a more detailed look these changes, I examined the specific subtypes of cohesion. The analyses of lexical cohesion showed significantly higher rates of synonym/near synonym use at midtreatment for the control group. However, when looking at how scores changed from pre- to midtreatment, the control group showed no substantial change in collocation and synonym/near synonym use, but a noticeable, albeit nonsignificant, increase for repetition. As LSA scores were related to repetition, the change in LSA for the control group at midtreatment may be attributed to this increase in repetition. This increase may reflect some underlying change in the cognitive network resulting from writing practice.

Changes in Lexical Cohesion for the Semantic Condition

Interestingly, the semantic group, despite showing no significant changes for LSA, showed changes in the different types of lexical cohesion with time. Like the control group, the semantic group showed increases in collocation between pre- and posttreatment, but unlike the control group, the change in collocation began earlier, between the pre- and midtreatment measures. Additionally, the semantic condition also saw a significant increase in synonym/near synonym use between mid- and posttreatment. These results show that the semantic group made greater changes in their use of collocation and synonym/near synonym use over the course of treatment than the control group. However, these gains were masked by the higher rates of lexical devices overall for the control condition. This finding is important, because it implies that semantic treatments stimulated the use of collocation and synonym/near synonym devices, thus suggesting that these aspects of lexical cohesion are emergent properties of semantics.

Changes in Conjunctions for the Syntax Condition

Given the significant findings for the incidence of connectives for the syntax group, I was curious about what changes in conjunction use may have accounted for the decrease at midtreatment. One difference for conjunction use between the syntax and control conditions was the use of fewer adverbials by the syntax group, with the control group showing a higher rate of adverbial use at mid- and posttreatment, and a nonsignificant trend for increasing adverbial use over time. However, this higher rate of adverbial use for the control group could not account for the differences between the two groups at midtreatment, as a significant difference for this variable only existed at posttreatment.

The only other significant change in conjunction use over time for either group was a change in the use of coordinating conjunctions by the syntax group. This change reflected a decrease in coordinated conjunctions at midtreatment. It should be noted that during the hand scoring of writing samples, we noticed that the vast majority of conjunction use by children in this study consisted of *and*, *then*, and *so* to coordinate T-units. Thus, the reduction in the incidence of connectives for the syntax group appeared to stem from a reduction in the use of these common coordinating conjunctions, implying that the syntax treatment may have had an effect on conjunction use.

Several explanations may account for this finding. For one, the syntactic treatments may have inhibited coordinating conjunction use, as syntactic treatments focussed on subordinating types. That is, practice with subordinating conjunctions may have created competing associative connections among verbal representations for conjunctions, thus decreasing activation for coordinated forms. Alternatively, children in the syntax condition may have been stimulated to use more subordinated and embedded sentence forms. Although

I expected an increase in subordinating conjunctions to co-occur with an increase in sentence complexity, embedded sentence forms, which are more complex than coordinated forms, do not necessarily require conjunctions. Descriptive statistics showed minimal changes in subordinating conjunctions across assessment times. However, this does not rule out the possibility that the syntactic treatments stimulated the use of a greater variety, but not number of subordinating conjunctions to replace previous coordinating forms. However, the data as collected have no way of revealing these differences.

Interestingly, this decrease in the number of overall conjunctions was followed by a return to baseline at posttreatment. Again, this finding may be the result of noise in the data, but may also reflect a developmental change, as such change rarely follows a smooth linear path (Cheshire, Muldoon, Francis, Lewis, & Ball, 2007; Flynn et al., 2007). Instead, developmental change is frequently characterized by discontinuities in the form of apparently sudden changes in behaviour followed by a period of great variability (van Dijk & van Greet, 2007). Variability in behaviour is likely to occur at the point at which a cognitive system is in transition (van Dijk & van Greet, 2007). That is, behaviours based on assimilation involving an already existing network show a consistent pattern; but when development involves accommodation, the existing network is changed by new input, resulting in a gradual change in the network (McLeod et al., 1998). During this transition between 'stages,' large fluctuations in responding may occur, especially following the first of the major shifts in behaviour (van Dijk & van Greet, 2007).

This pattern of change is the focus of much microgenetic research looking at intraindividual change (Siegler & Crowley, 1991). Although the swings in scores demonstrated in this study reflect intragroup rather than intraindividual change, van Dijk and

van Greet (2007) found a similar pattern of discontinuity across cases in their study of preposition use in four young children, albeit the shifts occurred at different times.

In this study, if several members of the syntax group were experiencing a shift in the use of conjunctions as a result of the daily practice with syntax tasks, the sudden decrease in conjunction use midtreatment may have reflected the first jump in behaviour, signalling the beginning of accommodation processes. If so, the following return to baseline may have reflected the fluctuation that occurs at these stage-transition times. Of course, the only way to know for sure would be to examine intraindividual differences using more than three time points. Such analysis was beyond the scope of this current study.

Summary

In this study I found that semantic skills predicted lower use of conjunctions, and children receiving semantic treatments showed an increase in the use of collocation and synonyms/near synonyms over time. I also found that syntax scores had a small negative relationship to LSA scores, and that children receiving syntactic treatments showed differences in the way they used coordinated conjunctions at midtreatment, as compared to the control group. Additionally, all three groups showed a decrease in mean distance over time; however the change appeared earlier for the two treatment groups. Furthermore, neither semantics nor syntax contributed to reference. Thus no single aspect of language appears to account for the development of cohesion as a whole; however semantics and syntax appear to contribute to this development.

Contributions of this Research

This research contributes to the body of literature on topics of cohesion, text generation, and dual coding theory. More specifically, it provides additional evidence for

developmental changes in cohesion, and adds fuel to the debate about the origins of cohesion. This study also helps to specify the implicit language processes involved in text generation, by demonstrating the relationships between oral language skills and a developmentally sensitive aspect of text generation (i.e. the construction of cohesive texts). Finally, the results of this study align with a dual coding explanation of cohesion.

Cohesion

The findings in this study are in keeping with previous research on the development of cohesion. The results support the concept that cohesion is an emergent property of both semantic and syntactic language abilities. Furthermore, there is evidence to suggest that syntax and semantics make different contributions to cohesion.

Development of cohesion. The findings of this research are consistent with findings from developmental studies of cohesion. For example, in this study I found a trend for decreasing mean distance over time. This finding has also been shown in cross-sectional studies of cohesion development (Fitzgerald & Spiegel, 1986; McCutchen & Perfetti, 1982; Yde & Spoelders, 1985). Although all three groups showed this pattern, the change for the control group did not occur until after midtreatment, whereas the treatment conditions showed more change between pre- and midtreatment, and slightly more change overall. This finding suggests that language treatments resulted in more improvement in mean distance between cohesive devices, as compared to no language treatment, and that the change came sooner. Furthermore, it did not appear to matter which language treatment was given as both treatment conditions saw decreases. However, eventual decline in mean distance for the control group suggests that some of the effect may be attributed to writing practice.

Another finding in cross sectional studies of cohesion is a trend for increased use of lexical devices with time. For example, Rentel et al. (1983) found increased use of lexical repetition across Grades 1 through 4, Rutter and Raban (1982) found greater use of collocation for 10 year olds than 6 year olds, and Crowhurst (1987) found an increasing trend for collocation and synonym use across Grades 6, 10, and 12. In this study of Grade 4 children (ages 9-10) there were no significant increases in LSA from one time to the next, with the exception of the control condition, which saw a spike in LSA at midtreatment that appeared to be attributable to an increase in lexical repetition. Given the findings of Rentel et al., this increase in lexical repetition may reflect a typical change seen in children at this age, accelerated by the extra practice writing. However, the significant increases in synonym/near synonym use and the earlier change in collocation for the semantic condition may reflect a trend that would normally occur a little later in writing development, suggesting that the semantic treatment may have stimulated the use of more sophisticated (i.e. later emerging) lexical cohesion devices.

A final developmental trend found in cross-sectional studies is an increase in the variety of conjunctions used (Crowhurst, 1987). The results regarding conjunction use in this study were less clear. The data did not reveal an increasing trend for conjunction types for any of the groups. It is possible that there was an increase in the variety of conjunctions within a type (e.g. a greater variety of subordinating temporal conjunctions or adverbials) that accompanied the reduction in coordinating conjunction use for those in the syntax condition; however, as collected, the data had no way of revealing this difference. None the less, Crowhurst (1987) also found decreases in the use of coordinating conjunctions like *then* and *so* with grade level. Thus, this finding for a reduction in coordinating conjunctions may

reflect an expected developmental trend, suggesting that the syntactic treatment may have influenced conjunction use, at least between pre- and midtreatment assessments.

Contributions of semantics and syntax to cohesion. The results of this study offer evidence that cohesion is related to both semantic and syntactic skills. Semantic abilities predicted lower rates of connectives in the regression analysis and semantic treatments appeared to stimulate increases in collocation and synonym/near synonym use. As for syntactic contributions to cohesion, syntactic abilities were negatively related to LSA. Additionally, those in the syntax condition showed changes in the incidence of connectives at midtreatment. This pattern was not found for the other two conditions, suggesting that syntax also contributes to cohesion. Additionally, like the semantic group, the syntax group showed a significant decrease in mean distance, also suggesting a contribution of both semantics and syntax.

The construct of cohesion. It has been argued that cohesion may be related to more than one underlying construct (Struthers et al., 2013). Some have argued that cohesion is a semantic construct (Halliday & Hasan, 1976), whereas others have argued that cohesion is also based on the grammatical/syntactic aspects of language (Palmer, 1999; Xi 2010). The results of this study suggest that, at least for children in Grade 4, some aspects of cohesion are indeed semantic in origin, and other aspects of cohesion are influenced by syntactic abilities. Furthermore, neither semantic nor syntactic skills accounted for the use of anaphor overlap, suggesting that some aspects of cohesion may be neither semantic nor syntactic.

Text Generation Revisited

Previous work has shown that language plays an important role in text generation (Abbott & Berninger, 1993; Kim et al., 2011; McCutchen et al., 1994). However, the

differential contributions of oral semantic and syntactic skills have not been directly examined. I reasoned that examining the role that semantics and syntax play in the development of a child's ability to write well-connected stories would tell us something about the role they play in writing in general. The results of this study suggested a facilitatory effect of semantic processing for lexical retrieval of related words (as indicated by increases in synonym/near synonyms and collocation) and an inhibitory effect on the use of conjunctions. Conversely, the results of Experiment 1 suggested that syntactic abilities may inhibit the retrieval of semantically related words. However, there was no corresponding decrease in LSA in the treatment study. Instead the syntactic treatment group showed a reduction in coordinating conjunctions at midtreatment. Although the reasons for this decrease are unclear, well developed syntactic skills may impact text generation by inhibiting the use of coordinated sentence forms.

This study was based on the assumption that semantics and syntax are independent but overlapping processes that both contribute to text generation. That is, I assumed that the ability to write a story involved semantic processes for the lexical retrieval of words that related to the story's global topic, and syntax for the use of conjunctions which signal the relationships between sentences within the story. Given these assumptions, I should have seen a clearer contribution for syntax. Instead cohesion showed a stronger and more stable relationship to semantic processes, suggesting that a reconsideration of the relationship between these two processes in text generation may be warranted.

Semantics and syntax as serial processes. One possible explanation for the findings is that semantics and syntax are independent and exclusive processes in text generation. For this to be true, semantic output could only result from semantic processing, and syntactic

output could only result from syntactic processing, because there would be no interaction or feedback between the two processes (Jones, 1987; Townsend, 1990). However, in a serial model, there would be feed forward mechanisms such that the first process would influence the process that follows it. However there would be no feedback from the second process to the first. Given the results of the regression analysis, the only viable explanation for a serial model would involve semantic processes preceding syntactic processes. This model would account for the negative relationship between vocabulary skills and conjunction use, given a feed forward inhibitory effect of semantics on syntactic constructions in text generation. However, I also found a small negative relationship between syntax skills and LSA suggesting an inhibitory effect of syntax on semantic productions. The fact that I found inhibitory effects in both directions implies feedback mechanisms between semantic and syntactic processing. Therefore, it does not appear that an exclusive or serial processes model would account for the findings of this study. Thus, the question becomes whether or not syntax and semantics are redundant or overlapping.

Semantics and syntax as redundant or overlapping processes. Given the stronger and clear findings for semantics in Experiment 1, the results could suggest that syntax is redundant with semantics. From this view, semantics would be seen as the dominant process, with syntactic coding occurring as part of semantic processing. Furthermore, semantic activation could occur without syntactic activation, but activation of syntax could not occur without activation of semantics. However, if semantics and syntax were redundant in this way, then disorders affecting semantics would always affect syntax; but this is not the case.

For example, around one third of children with Asperger's syndrome are reported to have semantic-pragmatic language impairments in the absence of syntactic difficulties

(Boucher, 2003, 2012). A similar pattern of impairment has also been reported for children with nonverbal learning disabilities (Volden, 2004). This evidence demonstrates independence of syntax from semantics and suggests that a redundant processing model with semantics as the dominant process does not seem adequate in explaining the relationship between the two.

Given the significant finding for syntax treatments in Experiment 2, another possible scenario for a redundant process explanation might have syntax as the dominant process. If this were true, then disorders affecting syntax would always impact semantics as well. Again, research on child language disorders shows that this is not true. For example, a subset of children with specific language impairment is reported to have discrete deficits in grammatical-syntactic abilities (van der Lely, 2005). Additionally, children with language disorders associated with prenatal drug exposure, for example, have been found to have syntactic deficits in the absence of vocabulary deficits (Lewis et al., 2013). Evidence such as this demonstrates independence of semantics and syntactic processes. However, it should be noted that early on in development, these processes may be redundant.

For example, in their functional neuroimaging study, Brauer and Friederici (2007) found that 6 year old children showed substantial overlap in brain activation patterns for semantic and syntactic processing; whereas adults showed differentiation in activation patterns. Additionally, in their study of children with acquired language disorders, Avila et al. (2010) found that strokes that occurred prior to 2 years of age always impacted syntax, but only impacted semantics about one third of the time, suggesting a dominant role for semantics in early language development. That is, neurological insults at this age did not impact semantics without also impairing syntax; however, syntax could be impaired without

impacting semantics. This pattern, however shifted as children got older. By the time children reached school-age, strokes were substantially less likely to impact syntax, with only 22% of the children in their study showing syntactic impairments, and 39% showing semantic impairments, suggesting increased independence of these processes. These studies support the findings of Tomblin and Zhang (2006) that semantics and syntax become increasing differentiated with age.

The children in this study were of an age when some degree of differentiation between semantic and syntactic processes is expected. However, the processes still may have more overlap than is seen in adults. The results showed that semantics impacted both lexical cohesion and the incidence of connectives in the writing of children in this study. Although syntax also contributed to cohesion, the role was not as clear owing to inconsistencies in the findings between the two experiments, and in the changes in conjunction use by the syntax treatment group over time. It may be that for children in Grade 4, semantics continue to play a more dominant role in text generation than syntax. This explanation would account for the consistent findings in this study for semantics to facilitate lexical retrieval, and the significant finding for the inhibition of conjunction use.

Given that syntactic skills are still in the process of developing during the school years (Puranik et al., 2008; Scott, 1988), fluctuations in syntactic productions and conjunction use should be expected. Such fluctuations would account for the inconsistencies found for the syntactic treatments, and suggest that, the associative networks that govern complex sentence structures and conjunction use may not yet be strong enough to outweigh the contributions of semantic processing. Thus, semantics may still take a lead in text

generation for this age group. That is not to say that syntax does not offer some contribution, but may do so to a lesser degree. This hypothetical relationship is depicted in Figure 3.

Over the course of development, increased experience with language would strengthen the structural arrangements of verbal representations and the sequential processing that governs syntactic productions. With increased strength, the ability of syntactic processing to win in competitions with semantic processing would balance out, thus leading to greater differentiation of syntax from semantics. As such, a similar study with older children or a more intensive syntactic treatment may have produced different results.

Dual Coding Theory Revisited

This study was theoretically grounded in dual coding theory. Semantic abilities were conceptualized as the referential processing between words and their nonverbal mental representations, operationalized by the depth and breadth of vocabulary. According to dual coding theory, one source of cohesion in writing is a strong nonverbal mental model, which referentially activates related words in the verbal system (Sadoski & Paivio, 2013). The results of this study provide evidence to support this explanation. That is, semantic skills influenced the way Grade 4 children use lexical and conjunctive cohesive devices.

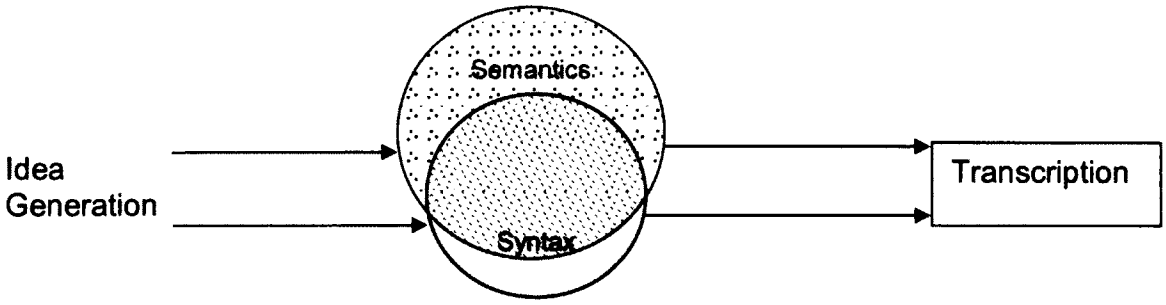

Figure 3. Possible relationship between syntax and semantics in text generation.

Dual coding theory also suggests that cohesion arises from associative processing within the verbal system, such that words and phrases that "go together" would be coactivated (Sadoski & Paivio, 2013). In this study, syntax was conceptualized as the hierarchical arrangement of well-learned word (including conjunctions) and phrase level representations sequentially processed by the verbal system to form grammatically correct sentence structures. Given this explanation of syntax, I predicted that syntactic abilities and treatments would result in more use of conjunctions, as the ability to use more complex sentences should also involve the use of more and varied subordinating conjunctions and adverbials. Although this prediction could not be substantiated by this research, the claim for a role of syntactic processing in cohesion could not be discounted. The small negative correlation between syntactic processing and LSA, the decrease in mean distance over time for those in the syntactic treatment, and differences in the way conjunctions were used midway through the treatment study by those in the syntactic condition suggest an effect of syntax on cohesion. However, syntactic processing seemed to have an inhibitory effect on lexical cohesion and coordinating conjunction use, rather than the facilitatory effect first expected. It should be noted that from their review of the literature, Sadoski and Paivio (2013) argued that the strength of nonverbal representations generally outweigh the verbal code in comprehension tasks. Although production is not simply the opposite of comprehension, the nonverbal code may still play a more dominant role in writing.

Limitations

In considering the theoretical and practical implications of this study, it is important to recognize the potential limitations. First, the sample size for Experiment 2 was small, and the number of variables large. These design features provided challenges for statistical

analysis. Second, the treatment period was only four weeks and scheduled in the spring, which may have limited the effects of the treatments. Third, there may have been effects for the videos that were used to elicit the writing at each time period. Finally, the effects of the treatment may have been made clearer if the writing samples used for data collection were taken directly following a treatment session. In this section I will discuss each of these issues in turn.

Sample Size

Experiment 2 of this study involved a small sample size. There were only 15 participants in each treatment condition and 14 in the control condition. Although group sizes were not large, in a repeated measures design there is a reduction in error variance resulting from measuring the same individuals over time. This reduction in error variance reduces the need for a large sample size. In fact, Stevens (1996) suggested that for a repeated measures design with three treatment groups and random assignment, 45 participants may be adequate.

Additionally, small sample sizes are common in microgenetic studies due to the large amount of data collected. Although I collected writing samples on a daily basis, for the purposes of this investigation, I only compared groups on pre-, mid-, and post-treatment writing. The more intensive analysis of daily writing will be the focus of future research.

In regards to the analyses conducted in this study, the problem related to sample size arose from the number of variables measured. When there are a large number of dependent variables, power is reduced in multivariate analyses as the sample size decreases (Stevens, 1996). Given the number of variables examined in this study, the small sample may have resulted in a loss of power in these analyses. Furthermore, five participants missed the

midtreatment assessment, and another three missed the posttreatment assessment, resulting in even smaller sample sizes for these assessment times.

Treatment Limitations

Experiment 2 was run over a four week period from the end of April to late May. During those four weeks, participants who were randomly assigned to conditions, attended a total of 16 treatment sessions and completed mid- and posttreatment writing assessments. Furthermore, treatment groups were led by different people. Timing, the amount of treatment provided, group leader differences, and individual differences may all have limited the effects of treatment on the variables of interest.

Timing. Experiment 2 began in the spring, during the final months of the school year. Practically speaking, this can be a difficult time of year to work with students, as there are frequent schedule interruptions due to the increased school events (e.g., sports day) and field trips that tend to occur at this time of year. In the four weeks of this study, one of the classes had a field trip, and on two separate occasions, pairs of children missed sessions to attend special events. Additionally, one school had to cancel sessions due to events within the school. Following this cancellation, treatment schedules in all three schools were adjusted, to keep the treatment schedule consistent across groups. These interruptions reduced the number of treatment sessions, with some students not receiving the benefit of the full 16 sessions due to school absences.

Aside from the practical issues that arose from year-end activities in the schools, there is some evidence to show that motivation of students also decreases in the spring months. For example, in their longitudinal study, Corpus, McClintic-Gilbert, and Hayenga (2009) found that for children in Grades 3 through 5, from fall to spring, there were

decreases in intrinsic and extrinsic motivation for school-related tasks, and less inclination to work to please authority figures. Given that the timing of this study coincided with this lower motivation, any potential effect may have been somewhat diminished by this decrease. Students may have been motivated initially due to novelty, but then their enthusiasm might have dropped as the novelty wore off. A drop in motivation may explain why we saw a return to baseline for the incidence of connectives in the syntax condition and for LSA in the control condition.

Amount of treatment. Like the timing of this study, the amount of intervention may have also impacted the amount of change. Warren, Fey, and Yoder (2007) defined treatment intensity as consisting of three components. The first is dosage, which they define as the number of times participants practice a skill or concept within a given session. The second component is frequency, which is the number of sessions offered within a given time frame. The final component is duration, which is the total amount of time over which the treatment sessions are conducted. They argued that treatment intensity, resulting from the combination of these three factors, is important as treatments delivered at different intensities may lead to varied results. In this study, although the number of sessions was the same for all conditions, absences of individual students for some of the sessions resulted in different intensities for those students. Additionally, even though tasks were the same and number of trials per activity was outlined in the treatment protocols, in some cases groups worked more quickly or slowly through the treatment activities, thus resulting in some minor variability in the dose of treatment from one group to the next. Finally, the duration of the study was only four weeks. It is possible that the treatment may have been more effective if it had been longer. For example, in their meta-analysis of treatment efficacy for children with language delays,

Law, Garrett, and Nye (2004) found that effect sizes for syntax treatment outcomes increased when treatments shorter than eight weeks were removed from the analysis. Although their study involved children with language impairments, it is possible that four weeks was not enough time to have a strong impact on language skills. Consequently, the short duration of language treatments may have resulted in only minimal effects on cohesion.

The impact of the short treatment duration on treatment effects may have also been impacted by the growth rate of syntax. During childhood, syntax skills have been shown to develop quite slowly (Puranik et al., 2008; Scott, 1988) with very little difference between grades. If syntax is slow to develop, it may also require a longer intervention period in order to affect a stable change. Vocabulary, on the other hand, continues to grow at a rapid pace throughout the early elementary school years (Anglin, 1993). If vocabulary develops quickly, then our semantic treatments may have been more effective than our syntactic treatments in creating stable change, which may have accounted for the slow and steady pattern of growth in lexical cohesion for the semantic group during treatment.

Group leader differences. Group leader differences also may have impacted the findings of this study. I carried out Experiment 2 with the help of four volunteer research assistants. Each treatment group was run by two alternating group leaders, with the exception of the control groups, which I lead. All semantic groups were run by a single pair of leaders, whereas the syntax groups were run by three different pairings. These arrangements could have affected the results in a number of ways.

First, the control groups were all run by one person. Given the lack of transition between leaders from one session to the next, this arrangement may have resulted in enhancing the performance of the control group, compared to the treatment groups with

alternating leaders. Enhanced performance of the control group would have led to reduced differences between the control and treatment conditions.

Treatment effects may also have been impacted by the three-way pairing for leaders in the syntax condition. Given that none of the groups shared the same pair of leaders, this could have introduced some unplanned variability into the treatments, potentially impacting the effect of those treatments. Additionally, I was involved in leading two of the syntactic groups. Given my extensive experience as a school speech-language pathologist, my delivery of the treatments may have varied somewhat from that of the trained research assistants. These differences in treatment delivery, particularly for the syntax condition, may have confounded the results of this study.

Individual differences. Another problem that may have impacted the results of this treatment study was the language skills of the participants prior to beginning the study. First of all, children likely varied in their combination of baseline language skills. For example, some children may have had similar syntactic and semantic abilities. In participants with such profiles, one type of processing would not likely dominate the other, and consequently these individuals may have been quite responsive to either treatment condition.

On the other hand, other participants may have had a relative strength or weakness in one or the other area of linguistic processing (i.e., higher semantic and lower syntactic abilities, or lower semantic and higher syntactic abilities). Given that the start state of a neural network impacts the responsiveness of that network to input (McLeod, et al., 1998), there may be a tendency to process language via the area of language strength for such individuals. If some of the participants in the syntax condition had pre-existing semantic strengths, then they may not have had the same response to treatment as those with relative

strengths in syntax. This explanation may account for why the inhibiting effect for syntax on LSA was found in Experiment 1, but not Experiment 2.

Similarly, if participants in the semantic condition had pre-existing syntactic strengths, they may not have responded as well to treatment as those with relative strengths in semantics. Consequently, group means may have been depressed, and within group variance increased, such that statistical group differences were hard to detect. Given the small sample size, a difference for a few students could have a strong impact on the group mean. The overall result would be a reduction of the treatment effect.

Procedures for Writing Sample Collection

Video effects. The procedures used to collect the writing samples may also have impacted results. Slomp (2012) argued that the complexities of writing make it susceptible to many factors. As has been described in popular models of composing (Bereiter & Scardamalia, 1987; Hayes and Flower, 1980), writing is a complex process, influenced by resources in the form of skills and knowledge, but also task demands. Slomp adds individual characteristics such as personal interest and responsiveness to this mix, arguing that differences among writers' products may result from any combination of these factors.

Several efforts were made to control the writing task to eliminate differences arising from task demands. All children wrote from the same videos at each time period. The order of videos was counterbalanced to control for possible order effects. I chose the videos on the basis of their content and similar story structure. Story content was related to daily life (e.g., a case of the hiccups) and all videos featured the same central characters (a penguin and his family), although in each story other characters were introduced. Additionally, two stories

were used to generate the cohesion measures at each time period to improve the generalizability of findings (Gerbil, 2009).

In Experiment 1, I found no effect for story order. However, the varying conditions and smaller sample size in Experiment 2 made order effects difficult to assess. Additionally, because each set of stories was written at different time points, and following treatments, I was unable to assess whether or not there were any between group effects for video content.

Despite these attempts to control for confounds, it is possible that the stories used at each time period were not equivalent. As argued by Slomp (2012), some individuals may not have been interested in or have the background knowledge for a particular story. As such, a given story may not have been representative for all participants. Typically, a difference such as this would not have dramatic effects on the finding for the group. However, given the small group sizes, such effects could have a pronounced impact on group means. Thus, I cannot be certain whether the effect found at a given time point was related to a change due to treatment, or a change due to story effects.

One final video effect may have been the medium itself. Given that the videos involved images and sound effects, but no language, watching the videos may have stimulated nonverbal representations, even for those students in the syntax condition. If the videos resulted in strong nonverbal mental models, then referential processing may also have been primed, thus competing with syntactic processing and diminishing the effect for the syntactic treatment on these writing samples.

Collection procedures. Even if videos were equivalent, the method of sample collection may also have impacted results. The writing samples in this study were collected before, midway through, and at the end of the treatment phase. On the days of the mid- and

posttreatment data collection, participants did not receive any treatment, and were assessed in a large group, with all participants from a given school writing at the same time. This procedure of having all participants write under the same conditions was important to allow for direct group comparisons (Abbott et al., 2006). Because the procedure for writing from videos took 50 minutes to complete, I made the decision on ethical grounds not to remove the children from class for an additional 30 minutes of treatment. That is, having students miss 80 minutes of instructional time in one day could have potential ill effects for students, outweighing the benefits of their participation in the treatment study. Such an arrangement would have also created difficulties for the teachers in planning class lessons.

Because writing samples were not collected directly following a treatment, the effects of the treatment on the writing may have been somewhat diminished. Instead, I may have seen stronger results if I had used the samples collected at the end of each the treatment session. To illustrate, participants in the semantic condition wrote a story based on the topic from that session, using a picture as a story prompt. This story writing followed activities in which participants learned new words, explored word meanings and relationships, and engaged in visual imagery, all related to the topic about which they wrote. These activities served to prime semantic processing, and the effect on the session writing sample may have been stronger than that for an unrelated sample taken at another time. Additionally, the assessments used for group comparisons were conducted under different circumstances than the writing completed in the treatment sessions.

Likewise, participants in the syntax condition wrote from a printed sentence starter. Although they wrote about the same topic as the semantic group, they had not been primed for content in any way, and they did not see a picture. Prior to writing, participants engaged

in activities of sentence combining and generating. This practice did not involve any particular topic and nonsense (but syntactically correct) forms were acceptable. These activities served to prime syntactic processing and the effects of treatment on the session writing samples may have also been stronger than that for a sample collected at a different time.

Implications of Findings

Noting the above limitations, this study contributes to our understanding of the development of cohesion, and the roles of semantics and syntax in writing. Consequently, it has practical implications for writing instruction as well as implications for future research.

Implications for Practice

Three findings have implications for writing instruction. First, given that children's breadth and depth of vocabulary predict the types of cohesive devices they use in their writing, consideration of vocabulary skills may be warranted when children have difficulty creating well connected text, as vocabulary may be a contributing factor to the problem. Attention to the vocabulary skills of children may be particularly warranted when a child's writing presents with repetitive use of coordinating conjunctions, and repetitious word use. Second, the findings of the treatment study support the use of instructional activities aimed at teaching new vocabulary, developing semantic networks, and using visualization skills to stimulate more cohesive text generation. Finally, the findings that both syntax and semantic treatments resulted in decreasing the mean distance among ties, suggest that oral language practice in general may be beneficial for the development of cohesion, even for children with typically developing language.

These findings are important to our understanding of what helps children write well. In particular, the focus of writing instruction in recent times has been on the development of metacognitive strategies (Graham & Harris, 2000; 2012). However, it has been demonstrated that implicit use of language structures precedes their strategic manipulation in writing (Berninger et al., 1994; Whitaker et al., 1994). Therefore, for those who have difficulty constructing texts with good cohesion, it may be helpful to precede strategy teaching with instruction of semantics and syntax. Furthermore, the findings from this study suggest that the oral language practice facilitates cohesion in writing.

Implications for Future Research

In this study I investigated the contributions of semantics and syntax to cohesive writing with the assumption that they were independent but overlapping processes. Although this study was not a process dissociation experiment, the results seem to support this view. Subsequent to findings for syntax that were not consistent or as strong as the findings for semantics, I hypothesized that, at least at the Grade 4 level, semantics may play a more dominant role than syntax in text generation. Further research is required to examine the merit of this hypothesis. In particular, it would be useful to determine whether or not semantics continued to offer a more stable and stronger input to text generation than syntax skills, or whether or not the contribution of syntax increases as the two linguistic processes continue to differentiate over time. Thus, study of individuals of different ages would help to clarify how the differentiation of semantics and syntax impacts text generation at different places along the developmental progression.

Another implication for future research comes from the lack of findings in this study for reference. That is, as measured in this study, anaphor overlap was not related to semantics

or syntax. Given the early development of expertise in pronoun use (Schneider & Hayward, 2010), a measure of the degree of reference use may not be indicative of developmental change in school-aged children. Perera (1984) indicated that reference ties emerge early in children's writing and by 9 years of age, are used extensively. However, these young children may still have difficulty using these ties accurately (Perera, 1984). Consequently analysis of ambiguities that arise from poorer use of reference ties may be a more informative measure of referential cohesion. As the typically developing Grade 4 children in this study produced relatively few ambiguities, studies using younger children or those with semantic or syntactic based language impairments may be helpful in determining the role that linguistic processes play in the development of referential cohesion.

Finally, future investigations may benefit from the inclusion of pragmatics and morphology to help determine what, if anything, these variables contribute to the use of reference devices. The role of morphology in transcription has already been demonstrated (Bourassa et al., 2011; Bourassa & Treiman, 2001), but its role in text generation is less well known. Investigations of these other components of language would help to further clarify the role that linguistic processes play in the development of cohesive writing.

Follow-up from the Current Study

Follow-up research using the data generated in this study may also clarify some of the results from this first set of analyses. In keeping with the intent of microgenetic study, further analysis will be conducted examining the treatment effects on the samples written directly following language treatments. Even if effects were not lasting, it is expected that semantic and syntactic treatments primed the respective language process, and the writing done directly following these treatments will show traces of this priming effect. By examining

samples written directly following treatments, we will be able to see whether primed semantic or syntactic processing had an immediate and/or accumulative effect on the emergence of cohesive devices in writing.

Additionally, examination of session generated writing samples will allow for the analysis of data from more time points. Multiple points of data may help clarify the jumps seen in some of the cohesion measures during this study. That is, such study might help to clarify whether or not the decrease in conjunction use for the syntax group at midtreatment was related to a stage shift in development.

Examining writing from multiple time points will also allow for modelling of growth. Latent class modelling techniques such as growth curve modeling are appropriate to use in examining developmental trajectories in studies with small sample sizes (Cheshire et al., 2007). Growth curve mixture modelling will allow me to determine if patterns of trajectories for the change in cohesion resulted from the treatment conditions alone, or from individual pretreatment differences in oral semantic and syntactic abilities (Abbott et al., 2006). In doing so, this analysis will help to clarify the role that individual differences in semantics and syntax play in the development of written cohesion.

Conclusion

In this study I examined the contributions of semantics and syntax to children's ability to write well connected text. I did so, as models of composition are vague in their treatment of language processes. This study provides evidence for the differential roles of semantics and syntax in writing. Indeed, writing research still has a long way to go in specifying how various component processes work together to allow an individual to achieve the complicated act of writing coherent texts.

Huey (1908/1968) stated that:

> ...to completely analyze what we do when we read would almost be the acme of a psychologist's achievements, for it would be to describe very many of the most intricate workings of the human mind, as well as to unravel the tangled story of the most remarkable specific performance that civilization has learned in all of its history. (p. 6)

Similarly, to finally understand the complete workings of cognitive processes involved in writing would be the pinnacle of one's academic and applied career. This study offers a few steps towards that goal, while leaving a career's worth of opportunities for future research.

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APPENDIX A

Ethics Approval, Information Letters, and Consent Forms

UNIVERSITY OF NORTHERN BRITISH COLUMBIA

RESEARCH ETHICS BOARD

MEMORANDUM

To: Lynda Struthers
CC: William Owen

From: Michael Murphy, Chair
Research Ethics Board

Date: December 14, 2012

Re: **E2012.1116.140.00**
Text Generation Processes in the Development of Written Cohesion: The Contribution of Semantics and Syntax

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Thank you for submitting the above-noted proposal to the Research Ethics Board (REB). The REB requires that letters from School District officials be forwarded upon receipt and prior to conducting any research on this project. The REB asks that you avoid any research off the School District site as it raises other ethical issues.

Once these letters has been received, we will be pleased to issue approval for the above named study for a period of 12 months. Continuation beyond that date will require further review and renewal of REB approval. Any changes or amendments to the protocol or consent from must be approved by the Research Ethics Board.

Good luck with your research.

Sincerely,

Dr. Michael Murphy
Chair, Research Ethics Board

School District Information Letter

Cindy Heitman, District Principal, Curriculum and Instruction

Prince George School District # 57

2100 Ferry Ave.,

Prince George, BC, V2L 4R5

[Date]

Dear Ms. Heitman,

I am a Ph.D. candidate from the Department of Psychology at the University of Northern British Columbia. I am seeking permission to conduct a research study with Grade 4 students in your district, during school hours. The title of this research project is *Text Generation Processes in the Development of Written Cohesion: The Contribution of Semantics and Syntax.* I am completing this research for the purposes of my doctoral thesis.

Purpose of the Research

I am studying development of cohesive devices in the writing of children. Cohesive devices are linguistic structures that help connect ideas in writing so that a written text forms a unified whole, rather than a series of poorly related ideas and sentences. In the assessment phase of this study, I will examine the relationship between oral language measures of syntax and semantics, and the use of cohesive devices in the writing of children in Grade 4. In the treatment phase, I will examine how changes in semantic and syntax abilities, resulting from specific oral language practice, change how children use cohesive devices in their writing.

Method

Recruitment of schools, classes, and students. I will recruit approximately 70 students for the assessment phase of this study. Students will be selected for the treatment phase if they meet baseline requirements for oral language and writing skills (based on their performance in the assessment phase). If more students meet criteria than are required, I will randomly select participants for phase two. I will approach a large elementary school first. Additional schools will be recruited, if necessary, until the sample/group size requirements have been satisfied. To recruit schools, I will first approach building administrators. Then, with their agreement, I will provide an information session to the Grade 4 teachers in that school and seek agreement to conduct research with students from their classrooms. Once a teacher agrees to participation, information will be provided to parents and individual consent for their child's participation will be sought. A separate invitation and consent form will be used for participants of phase two.

Procedures. Upon receiving parental consent for a child to participate, each child will be assessed individually for oral language abilities using a combination of standardized instruments and elicited language tasks. This assessment will be conducted by the researcher, or a trained assistant. Two writing samples will also be collected from each participating child. The writing samples will be collected in a group assessment, by showing the students a video, and having them write, for 15 minutes, about the event depicted. If this assessment is conducted in the classroom, only samples from students with signed consents will be collected by the researcher. Writing samples will be transferred to text files and returned to the classroom teacher at the end of the treatment period. The language assessment is

expected to take between 30 and 45 minutes per student. The writing assessment is expected to take up to 50 minutes (or 25 minutes if done in two sessions).

Following the initial assessment, students who meet criteria for inclusion will be invited to participate in phase two and another parental consent will be obtained. Children will then be randomly assigned to one of three treatment groups, or a control group. Each treatment group will meet for 30 minutes daily for four weeks. During these groups, students will participate in activities designed to stimulate their oral semantic and/or syntax language skills. Groups will be run by trained research assistants (and/or the primary researcher if not enough assistants can be recruited), and monitored by the primary researcher. At the end of each session, all students (including those in the control group) will complete a 10 minute writing task. The researcher will make a text copy of the writing samples, and return the originals to the classroom teacher at the end of the study for his/her own use.

Ethical Considerations

Participation is voluntary. Participation in this study is voluntary, and individuals, teachers, or schools are free to withdraw their participation at any time during the study. Data, for children whose parents have requested their withdrawal from the study, will be destroyed.

Privacy and confidentiality. Upon receiving consent, each student will be assigned a number. Language and writing protocols will then be identified only by the assigned number. The identity of individual students, teachers, and schools will be known to the researcher, but will not be included on the data. All student information, consents, and coded language and writing assessments will be kept in a locked cabinet at UNBC. Language protocols will be stored for five years and then shredded. The writing samples will be transferred to text files,

and the originals returned to the school at the completion of the treatment phase. The anonymous text files will be retained by the researcher for future research purposes.

Potential benefits. The development of cohesion in writing is important, because it allows writers to communicate their ideas effectively and coherently express what they know. To date, the information available in the literature about how cohesion develops is sparse. Furthermore, the contributions of oral language skills to writing are not clear. This research will add to this body of knowledge. Providing further evidence of how oral language skills contribute to writing will help inform educational practices. In addition to the scholarly contribution of this study, it is anticipated that students participating in this research will benefit from the small group oral language activities and daily writing practice.

Potential risks. The risks to participants in this research are minimal as their identities are protected and the tasks required are in keeping with the BC Ministry of Education Intended Learning Outcomes for Language Arts. However, participation in the study will require time away from other instructional tasks. The amount of time for each child to participate in the assessment phase of this project should be about 30 to 45 minutes for the individual language assessment, and 50 minutes for the writing assessment. During the treatment phase, the amount of time for group sessions will be 30 minutes per day (up to 40 minutes including the time to collect students and return them to class) for four weeks. The cost of this time will be off-set by the treatment benefit to students and, if teachers choose, access to the generated writing samples for classroom based assessment.

Sharing results. At the conclusion of this research project, I will provide feedback on aggregate results through presentations to district staff and parents. The results of this research will also be submitted for publication in academic journals. If you have any further

questions regarding any aspect of this project, please feel free to contact me or my supervisor, Dr. William Owen. I can be reached by email at struther@unbc.ca, or by phone at 250-960-5267. Dr. Owen can be reached at William.Owen@unbc.ca or at 250-960-6657. Any concerns or complaints should be directed to the Office of Research, UNBC at 250-960-6735 or reb@unbc.ca.

Sincerely,

Lynda Struthers, Ph.D. Candidate,

University of Northern British Columbia

Principal Information and Permission

My name is Lynda Struthers. I am a Ph.D. candidate from the Department of Psychology at UNBC. I am asking for your permission to conduct a research study in your school, during school hours. The title of the study is *Text Generation Processes in the Development of Written Cohesion: The Contribution of Semantics and Syntax.* I am completing this research for the purposes of my doctoral thesis and hope to publish the results in other future publications. The approval of the District Principal of Curriculum and Instruction is attached.

Purpose of the Research

To examine how oral language skills contribute to children's ability to write cohesively. This study consists of two parts.

1. Comparison of the oral language skills and the writing skills of children
2. Examination the effect of practice with oral language skills on cohesion in writing.

What I Will Be Doing

I will recruit approximately 70 Grade 4 students for part one, some of whom will be invited to participate in part two. I will provide information to parents via a parent's information night, a letter sent home, and (if you are willing) a note in the school newsletter. Parents will be required to give consent for their children to participate. All verbal Grade 4 children in the classes of willing teachers will be invited to participate in part one. Any writing generated by students in this study will be returned to the classroom teacher at the end of the study for his/her own assessment use.

Part one. Each child's oral language will be assessed one-on-one by the researcher or a trained assistant and will take between 30 and 45 minutes per student to complete. Two

writing samples will also be collected in a group assessment. This activity is expected to take approximately 50 minutes to complete (or 25 minutes if done in 2 sessions).

Part two. Children will be randomly assigned to treatment groups of 5 students each or a control group. Treatment groups will meet twenty times for 30 minute session over a period of approximately four weeks. Groups will be led by me or a trained research assistant (supervised by me). During the treatment sessions, children will work on oral language activities designed to stimulate vocabulary and/or sentence structure skills. (I will not reveal which students are receiving which treatments.) All children will be asked to write during each session. A group writing assessment (as in part one) will also be conducted mid-way through and at the end of treatment.

Ethical Considerations

Participation is voluntary. You are free to cancel the participation of your school in this research at any time. Participation of children is also voluntary. Parents and children may withdraw from the study at any time, at which time their data will be destroyed, unless the results have already been reported.

Privacy and confidentiality. The identity of individual students, teachers, and schools will be known to the researcher and assistants, but will not be included in the data. The data will be stored in a locked cabinet in my office at UNBC, and only I, my research assistants, and my supervisor will have access to the information. Documents with identifying information will be destroyed when my dissertation is complete, or after 2 years, whichever comes first.

Potential benefits. The activities used in this study are consistent with the ILOs for Language Arts as specified in the BC Ministry of Education IRPs. This study will provide

students with small group oral language and writing practice. This study can help improve our understanding of how cohesion develops in children's writing. A better understanding of the relationship between oral and written language skills can help teachers make informed decisions about instruction.

Potential risks. Participation in the study will require time out of class; however, the cost of this time will be off-set by the potential treatment benefit to students and the generated writing samples for classroom based assessment purposes.

Sharing results. Feedback on the findings from this study will be offered to you through a presentation at a staff meeting, if you so choose, and on a district professional development day.

I appreciate your consideration of this research project and look forward to working with your staff. If, at any point, you have any further questions regarding any aspect of this project, please feel free to contact me or my supervisor, Dr. William Owen. I can be reached by email at struther@unbc.ca, or by phone at 250-960-5267. Dr. Owen can be reached at William.Owen@unbc.ca or by phone at 250-960-6657. As well, concerns or about this project can also be directed to the Office of Research, UNBC at reb@unbc.ca or at 250-960-6735.

Sincerely,

Lynda Struthers

I, _____ principal of _____

give permission to Lynda Struthers, Ph. D. candidate at University of Northern British Columbia to include this school in the above described research project.

_____ _____

Signature Date

Teacher Information Sheet

My name is Lynda Struthers. I am a Ph.D. candidate from the Department of Psychology at UNBC. I am seeking your cooperation in conducting a research study with Grade 4 students in your class. The title of this study is *Text Generation Processes in the Development of Written Cohesion: The Contribution of Semantics and Syntax.* I am completing this research for my doctoral thesis.

Purpose of the Research

To examine how oral language skills contribute to children's ability to write cohesively. This study consists of two parts.

1. Comparison of the oral language skills and the writing skills of children
2. Examination of the effect of practice with oral language skills on cohesion in writing.

What I Will Be Doing

All verbal children in your class will be invited to participate in part one of this study, some of whom will be invited to participate in part two. I will be responsible for providing parents with information about the study, but may ask that you hold signed consent forms returned to the school, until I am able to collect them from you. Any writing generated by students in this study will be returned to you at the end of the study for your own assessment use.

Part one. Each child's oral language will be assessed in a one-on-one session expected to take between 30 and 45 minutes per student to complete. Two writing samples will also be collected in a group assessment. This activity is expected to take approximately 50 minutes to complete (or 25 minutes if done in 2 sessions).

Part two. A sub-set of children from Part One will be invited to participate in Part Two. Children will be randomly assigned to groups of 5 students each. Treatment groups will meet twenty times for 30 minute sessions over a period of approximately four weeks. During the treatment sessions, children will work on oral language activities designed to stimulate vocabulary and/or sentence structure skills and will complete a 10 minute writing sample. Those in the control group will practice writing only. Please note that up to 40 minutes of time may be required to allow for movement of students to and from class. I will not reveal which students are receiving which treatments. A group writing assessment will also be conducted mid-way through and at the end of treatment.

Ethical Considerations

Participation is voluntary. You are free to cancel the use of your class time for this research at any time.

Privacy and confidentiality. Your identity and the identity of the students will be known to the researchers, but will not be included on the data. Information regarding student performance will be kept strictly confidential.

Potential benefits. The treatment activities will supplement your current language arts programs and are in keeping with the BC Ministry of Education ILOs. This study will provide students with small group oral language and writing practice. This study can help improve our understanding of how cohesion develops in children's writing. A better understanding of the relationship between oral and written language skills can help teachers make informed decisions about instruction.

Potential risks. Participation in the study will require time out of class, however, the cost of this time will be off-set by the potential treatment benefit to students and the generated writing samples for classroom based assessment purposes.

Sharing results. The findings of this study will be shared through publications and a presentation at a staff meeting and/or a district professional development day.

I appreciate your consideration of this research project and look forward to working with your staff. If, at any point, you have any further questions regarding any aspect of this project, please feel free to contact me or my supervisor, Dr. William Owen. I can be reached by email at struther@unbc.ca, or by phone at 250-960-5267. Dr. Owen can be reached at William.Owen@unbc.ca or by phone at 250-960-6657. As well, concerns about this project can also be directed to the Office of Research, UNBC at reb@unbc.ca or at 250-960-6735.

Sincerely,

Lynda Struthers

Parent Information Letter and Consent Form for Experiment 1

Dear Parents,

My name is Lynda Struthers. I am a researcher from UNBC. I am doing a study on how children's spoken language skills help their ability to write well. I am doing this study for my doctoral thesis and hope to publish the findings from this study in other future publications.

Who am I Looking For?

Students in Grade 4 who can speak and write in English.

What Will Happen?

I or a research assistant will test your child's spoken language in a one-on-one session. This should take about 45 to 50 minutes to complete. Your child will then be asked to write 2 short stories, in a group setting. The teacher will get a copy of this writing. This will take about 50 minutes of class time. Following this part of the study, your child may also be invited to be in a second part of the study. If that happens, I will give you more information, and ask for your permission to include your child in the second part.

Will the information about your child be kept private? Yes. Information about your child will not be shared with anyone. I will not put your child's name on any of the tests, and all papers will be kept in a locked cabinet in a private research office at UNBC. Only I, my supervisor, and my assistant will see the information. Anything with your child's name on it will be shredded when the study is finished or after 2 years. The language tests will be shredded after 5 years. I will keep typed electronic copies of your child's writing for future study. These copies will have no names, so no one will know who wrote them. I will not talk about your child when I report the results of the study. No one, other than you, your

child, other children in the study, your child's teacher, and the researcher will know that your child was in the study.

If I give permission, can I change my mind? Yes. You can change your mind any time. You can ask to have your child taken out of the study and his/her information destroyed, unless I have already reported the results.

Why should I let my child be part of the study? Your child will get extra practice writing. This study will help teachers understand more about how children learn to write well.

What are the problems? Your child will miss some class time if tested during the day. If you wish, I can make an appointment with you for another time to test your child (e.g. at lunch or after school).

Where can I Get More Information?

Come to the parent meeting [insert date] at [time] at [place]. Visit https://blogs.unbc.ca/struther/, email struther@unbc.ca or leave a message at 250-960-5267 and I will call you. Contact my supervisor, Dr. William Owen, by email (William.Owen@unbc.ca) or phone (250-960- 6657). If you have enough information, and you want your child to be in the study, please read the attached form with your child, fill in the information, and sign it.

Sincerely,

Lynda Struthers, PhD Candidate, Psychology Department, UNBC

Any complaints about this project should be directed to the Office of Research at UNBC by emailing reb@unbc.ca or calling 250-960-6735.

Consent Form

Researcher. Lynda Struthers, Ph.D. Candidate, Department of Psychology, UNBC

What the study is about? Students in Grade 4 from your child's class are being asked to be in a study on speaking and writing. If your child joins this study, a researcher will test your child's spoken language skills in a one-on-one session. After that, in a group with other Grade 4 children, your child will write two short stories.

Please read this form with your child. If you both agree, fill in the information and sign this form. Please check each box to show that you have read and understand the information.

Privacy.

☐ The information about your child's language and writing will be kept private.

☐ The researcher will keep a typed electronic copy of your child's writing for future studies. Your child's name will not appear on the copy, so no one will know who wrote it.

☐ At the end of the study, I will give your child's teacher the stories that your child wrote.

☐ All information, including this form, will be kept in a locked cabinet in a private office at UNBC.

☐ When I report the results of this study, your child will not be named.

Your child does not have to participate.

☐ Your consent is voluntary. Your child *does not have to* participate. Your child will not be affected in any way if you decide not to allow him/her to be in the study.

☐ If you give permission now, you or your child can pull out of the study at any time. With your request, I will remove and destroy any information about your child, as long as I have not already reported the results.

Questions. If you have any questions you can contact me, Lynda Struthers, at 250-960-5267 or by email at struther@unbc.ca or my supervisor, Dr. William Owen at 250-960-6657 (email: William.Owen@unbc.ca). Complaints should be made to the Office of Research at UNBC by emailing reb@unbc.ca or calling 250-960-6735.

To give permission for your child to be in this study, please fill in the information and sign below:

I_____ give permission for my child _____
(print your full name) (print child's full name)
to be in the study described here.

Choose one:

☐ Participation in the assessment during regular class times.

☐ Participation in the assessment by appointment outside of regular class times. Please indicate your preference below:

- o Lunch time assessment
- o After school assessment at the school (please provide a number where you can be reached to set up a date for this appointment: _____).

As well, please provide the following information about your child:

Birthdate (month, year): _____
First language spoken: _____
Other languages spoken: _____

_____ _____ _____
Signature of Parent/Guardian Relationship to child Date

After you fill in this form, keep the information letter for yourself. Put the signed form in the envelope and seal it. Return the sealed envelope to the school.

Parent Information Letter and Consent Form for Experiment 2

Dear Parent,

Earlier this winter, your child was in a study looking at spoken language and writing. I would like to invite your child to participate in the second part of this study. As with part one, I am doing part two of this study for my doctoral thesis and hope to publish the findings in other future publications.

What Will Happen?

Students in Grade 4 from your child's school will be divided into groups, by pulling their names out of a hat. Some of the groups will practice different language skills. One group will not get any extra practice with language. All groups will practice writing. All of your child's writing will be given to the teacher at the end of the study. The practice groups will work with a researcher for a half hour daily for about 4 weeks.

Will the information about your child be kept private? Yes. Information about your child will not be shared with anyone. I will not put your child's name on any of the writing, and all information about your child will be kept in a locked cabinet in a private office at UNBC. Only I, my supervisor, and my assistants will see the information. I will keep typed electronic copies of your child's writing for future study. These copies will have no names, so no one will know who wrote them. I will not talk about your child when reporting the results of the study. No one, other than you, your child, other children in the study, your child's teacher, and the researchers will know that your child was in the study.

A few sessions may be videotaped. The video will be focused on the researcher and be used to make sure that the activities are being in done the best way. No one except me and the other researcher in the video will see it. After we look at it, the video will be destroyed

If I give permission, can I change my mind? Yes. You can change your mind any time. You can stop allowing your child to come to the group sessions and can ask to have your child's information taken out of the study and destroyed, unless I have already reported the results. Your school principal or classroom teacher also has the right to stop the study at any time.

Why should I let my child be part of the study? Your child will get extra practice writing and, if in one of the language groups, small group practice with language skills. This practice will help with your child's writing. This study will help teachers understand more about how children learn to write well.

What are the problems? Your child will miss class time to attend small group sessions.

Where can I get more information? Come to the parent meeting [insert date] at [time] at [place]. Visit [insert web address], email struther@unbc.ca or leave a message at 250-960-5267 and I will call you. Contact Dr. William Owen by email (William.Owen@unbc.ca) or phone (250-960- 6657). If you have enough information, and you want your child to be in the study, please read the attached form with your child, fill in the information, and sign it. Thank you for your time.

Sincerely,

Lynda Struthers, PhD Candidate, Psychology Department, UNBC

* Any complaints about this project should be made to the Office of Research at UNBC by emailing reb@unbc.ca or calling 250-960-6735.

Consent Form

Researcher. Lynda Struthers, Ph.D. Candidate, Department of Psychology, UNBC

What the study is about? In part two of this study, a researcher may work with your child in a small group to practice spoken language and writing, or your child may just practice writing. The study is expected to last for about 4 weeks. Children will be pulled out of class for a half hour daily for the practice sessions. There is more information about the study on the attached form.

Please read this form with your child. If you both agree, fill in the information and sign this form. Please check each box to show that you have read and understand the information.

Privacy.

☐ The information about your child's writing will be kept private.

☐ The researcher will keep a typed electronic copy of your child's writing for future studies. Your child's name will not appear on the copy.

☐ At the end of the study, I will give your child's teacher the stories that your child wrote.

☐ All information, including this form, will be kept in a locked cabinet in a private office at UNBC, and will be destroyed when the study is finished.

☐ When I report the results of this study, your child **will not** be named.

Use of video tape.

☐ Occasionally, a video of the researcher will be taken to make sure the activities are being done the best way. Only I and the other researcher in the video will look at it. Once the video has been viewed, it will be erased.

Your child does not have to participate.

- ☐ Your consent is voluntary. Your child *does not have to* participate. Your child will not be affected in any way if you decide not to allow him/her to be in the study.
- ☐ If you give permission now, you or your child can pull out of the study at any time. With your request, I will remove and destroy any information about your child, as long as I have not already reported the results.
- ☐ Your child's principal or classroom teacher can also stop the study.

Questions. If you have any questions you can contact me, Lynda Struthers, at 250-960-5267 or by email at struther@unbc.ca, or my supervisor, Dr. William Owen at 250-960-6657. If you have any complaints, please contact the Office of Research at UNBC by emailing reb@unbc.ca or calling 250-960-6735. To give permission for your child to be in this study, please fill in the information and sign below:

I_____ give permission for my child _____
(print your full name) (print child's full name)

to be in the study described here.

_____ _____ _____

Signature of Parent/Guardian Relationship to child Date

After you fill in this form, keep the information letter for yourself. Put the signed form in the envelope and seal it. Return the sealed envelope to the school.

APPENDIX B

Instructions for Writing Assessments

Below are the scripted instructions given to the participants for the pre-, mid-, and posttreatment writing assessments. Quotation marks indicate the instructions given by the researcher. Prior to giving the instruction, the researcher handed four sheets of paper to the children, two with their identification numbers and two extra. To make sure the correct sheets went to the correct students, each stack of papers was clipped and labeled with their name on a removable sticky note. The students were instructed to remove the sticky note before beginning.

The instructor began by saying, "Today we are all going to do some writing together. I am going to show you two video clips. After each video, you will write a story about what happened in the video. The story is for your teacher who has not seen these videos. Please do not put your name on your papers." After giving instructions, the researcher played the first video.

After viewing the first video the children were given the following instructions. "Now you will write a story for your teacher that tells about the video." At this point the researcher fielded any questions from the group, then continued with, "Remember, that a good story has a beginning, middle, and end, and talks about a problem and how that problem is solved. Try to write for the whole time. You have 15 minutes to write the best story that you can. Go."

The researcher then started the timer which was previously set for 15 minutes. If children asked for help during the writing time they were instructed to just try their best. When there was one minute left on the timer the researcher said, "You have one minute left

to finish your stories." When the timer ran out, the researcher said, "Time is up. If you are part way through a sentence, you may finish that sentence; otherwise, please put your pencils down."

The children then were instructed to clip the papers they were handed together and hand them to the researcher. As the samples were collected they were checked to make sure that the identification numbers were written on the papers on which each child wrote, and that names were removed.

APPENDIX C

Scoring Procedures for Word Associations

Score 0 if there is no discernible relationship between the stimulus and response words or if no response or a "don't know" response is given. Use this score when the relationship to the stimulus word is obscure or for a word that is similar in only in sound. Examples of responses that would score 0 include repetitions of the stimulus, rhyming words, and nonsense words.

Score 1 if the response has a minimal or idiosyncratic semantic relationship to the stimulus word. A word may be judged as having a minimal semantic relationship if there is some *semantic* relationship that is *neither thematic nor paradigmatic*. An idiosyncratic response is one in which the meaning is specific to the child. For example, they may give the name of a particular person, place, or pet. Specific examples are listed in Table C1.

Score 2 if the relationship between the stimulus and response word is thematic. Such a response might include a word that would occur in the same context, but is not synonymous, in the same category, or the same part of speech as the stimulus word. The word may be symbolically related or reflect a functional relationship. The response reflects an understanding of the word. Specific examples are listed in Table C1.

Score 3 if the relationship between the stimulus and response word is paradigmatic or taxonomic. The word should be the same part of speech (noun or verb) and be a synonym/ near synonym, be from the same category (coordinates, sub-ordinates, super-ordinates), have a whole-part relationship, or be an antonym to the stimulus word. Specific examples are listed in Table C1.

Score 4 if the relationship between the stimulus word and response is syntactic. Such responses would be a word that might commonly follow or precede the word in a sentence and *does not relate in meaning.* Examples include an adjective given in response to a noun or an adverb given in response to a verb, or a response that might be a word that follows or precedes the target word in a common phrase. Examples of responses that would score 4 include '*you*' in response to love, or 'on' in response to 'purpose.'

Score 5 if the response is a derivation of the stimulus word. An example would be if the response is the stimulus word with a different or additional bound morpheme attached. Examples include words like 'healthy' in response to 'health' or 'original' in response to 'origin.'

Table C1

Common Responses from Participants in this Study by Score

	Common Responses by Score		
Stimulus	1	2	3
loyalty	name of friend or pet, responsibility	friend, dog, king, queen, (agents/objects of loyalty) trust	
origin	culture, type		
health	safety	vegetable, fruit, sick, strong	
mystery	book	find	
walk	road, street		run
machine	work	Mechanic, gas, wires, tools	
garage		car	
decide		answer	think
farm		cow, horse, pig, etc.	
enjoy		fun, happy	
suspect (v)			think, know
purpose		thinking	
complain		mad, angry, sad	
magnet		stick, fridge	
chair		sit	
energy		fast, run, hyper, (agents or objects of energy)	

Table C1 continues

Table C1 continued

Stimulus	1	2	3
pronounce		word	say, talking, speak
worship		God/gods	obey
table		dinner	
draw		colourful, picture, cartoon	
helmet		safety, bike, protective	
carrot		rabbit, eat	
emergency	run, fast, hurry	help, fire, ambulance	
eat		food	
believe	names in what they believe (e.g. fairies)	trust	
fact		true, book	
love		family, heart	hate
river	float		any body of water, water
terror	Tower (of Terror)	scared	
soak		relax, water	wet
stretch	morning	loose, yawn, exercise	
law		police	
coin			money

APPENDIX D

A Categorized List of Dependent Variables

Table D1 contains the dependent variables used in this study. Each is aligned with the type of cohesion to which it refers. A brief definition of each is also provided.

Table D1

Dependent Variables and the Types of Cohesion Measured

Dependent Variable	Type of Cohesion	Definition
Anaphor overlap (ANA)	Reference	The proportion of sentences that contain a pronoun tie to the previous sentence. This variable is generated by Coh-Metrix.
Pronouns	Reference	Pronouns used to replace a previously mentioned noun. This variable is hand-generated.
Demonstratives	Reference	The use of demonstratives (e.g., *the, this, that*) used to refer back to a previously mentioned noun. This variable is hand-generated.
Latent Semantic Analysis (LSA)	Lexical	A mathematical representation of the semantic relationship between adjacent sentences. This variable is generated by Coh-Metrix.
Repetition	Lexical	The same word used to refer to a previously mentioned character, event, place, or item. This variable is hand-generated.

Table D1 continues

Table D1 continued

Dependent Variable	Type of Cohesion	Definition
Synonym/near synonyms	Lexical	The use of different words to refer to a previously mentioned character, event, place, or item, including the use of true synonyms, near synonyms, superordinates, or subordinates. This variable is hand-generated.
Collocation	Lexical	The use of compliments (*funny & laugh*) or converses (*old & new* or *ask & tell*). These are words that commonly co-occur. This variable is hand-generated.
Incidence of connectives (CON)	Conjunction	The total number of conjunctions used to connect clauses. This variable is generated by Coh-Metrix.
Coordinating conjunctions	Conjunction	The use of coordinating conjunctions to sequentially add information (e.g., *and, so, & then*). This variable is hand-generated.
Subordinating temporal conjunctions	Conjunction	The use of subordinating conjunctions to mark temporal relationships between events (e.g., *before & after*). This variable is hand-generated.

Table D1 continues

Table D1 continued

Dependent Variable	Type of Cohesion	Definition
Adverbials	Conjunction	The use of adverbs or phrases to mark temporal relationships between events (e.g., *the next day*, *suddenly*). This variable is hand-generated.
Causal conjunctions	Conjunction	The use of conjunctions to indicate causal relationships between events (e.g., *because* & *therefore*). This variable is hand-generated.
Adversatives	Conjunction	The use of conjunctions to indicate competing relationships between events (e.g., *but* & *however*). This variable is hand-generated.
Mean distance	Reference and Lexical	The mean of the distances for all mediated and remote (non-sentence adjacent) reference and lexical ties. This variable is hand-generated.

APPENDIX E

Session Topics and Writing Prompts

Table E1 contains a list of the themes used in each semantic treatment, and the types of conjunctions addressed in each syntax treatment. It also provides a brief description of the pictures, and lists the story sentence starter used to elicit the writing samples for each session. The semantic treatment condition wrote from the picture prompt, the syntax group wrote from the sentence prompt, and the control group wrote from the combined picture and sentence.

Table E1

Session Topics and Writing Prompts for Each Day of Experiment 2

	Conditions			
Day	Semantic	Syntax	Picture Prompt	Sentence Prompt
1	Seasonal clothing	Sentence combining with no conjunctions	A boy getting dressed to play in the snow	It was a cold day and Jack was getting ready to play outside.
2	Winter activities	Compound subjects and predicates	Two boys building a snowman	It was a crisp winter's day, and the boys decided to make a snowman.
3	Winter sports	Either-or, neither-nor	A family group ice skating	Sunday mornings at the skating oval were usually fun for the Smith family.

Table E1 continues

Table E1 *continued*

Day	Semantic	Syntax	Picture Prompt	Sentence Prompt
4	Autumn	As well as, in addition to, additionally	A group of people raking leaves	It was a bright crisp autumn day, so they all headed outdoors to rake the leaves.
5	Outdoor summer activities	Mixed conjunctions from the week	Four children playing in a backyard pool	It was a nice day, so Clint and Allie went to visit their friends who had a small pool set up in their yard.
6	People and places around town	Because, as a consequence of	A car with flat tire parked near some shops.	They thought it would be an ordinary trip to town to run errands and do their shopping.
7	Restaurant	Consequently, therefore	Various people in a restaurant	The family had just sat down at their favourite restaurant.
8	Library	Mixed causal conjunctions	A boy at the circulation desk of a library	Sam always looked forward to visits to the library, and this Saturday was no different.

Table E1 continues

Table E1 continued

Day	Semantic	Syntax	Picture Prompt	Sentence Prompt
9	Kitchen & cooking	First, second, third, next	A lady and a girl baking cookies in the kitchen	Just like every other Saturday morning, Cassie and her mom went to work baking cookies.
10	Meal time and food	When	A family sitting at the table at mealtime and a man talking on a phone.	They were just starting to eat dessert when the telephone rang.
11	Chores	Until	A family group of people cleaning up the kitchen.	It was Saturday morning, so Sam and Amanda got busy helping their parents with the chores.
12	Toys, games, and sharing	Before & after	Two children talking with an adult in a toy filled bedroom.	It was a rainy day, so the children were forced to play inside.
13	Evening routines and activities	Mixed temporal conjunctions	Two children in pajamas with a babysitter and adults leaving.	Cindy and David, excited to spend the evening with their favourite sitter, waved to their parents.

Table E1 continues

Table E1 continued

Day	Semantic	Syntax	Picture Prompt	Sentence Prompt
14	Camping	However	A family group camping.	It started out like any other camping trip, but little did they know, this trip would be much different.
15	Animals in the wild & nature	Although	Two boys with fishing poles looking at moose and geese in a pond.	Alex and John thought that it would be a typical fishing trip, but they were very surprised by what they saw.
16	Sports, athletics, racing	If, although, however	A group of children running a foot race.	The children were all excited that it was the day of the big cross-country race.

APPENDIX F

Sample Session Scripts

Below are examples of scripts that were used to guide the sessions in Experiment 2. One sample script from each condition is included. The words that group leaders used to instruct the students are presented in bold italics. Additional instructions for the activities are denoted by in plain font and presented in square brackets.

Semantic Condition: Session 4

1. Greetings and check-ins
2. Visualization activity: ***Look at this picture.*** [Show black line drawing of people raking leaves.]. ***What is happening?*** [Wait for students to respond.] ***Today we are going to talk about fall. What's another word for fall?*** [Wait for a response. If one isn't offered tell them it's "autumn."] ***Let's take a moment to think about a time when you were outside on an autumn day. What things pop into your mind? What are you doing? What things do you see? What do you hear? What do you feel or smell? How are you feeling?*** [Give the students a moment to visualize then have them report what they were thinking about. Have everyone tell two things. As the students tell you their ideas, make note of key words nouns, verbs, adjectives/adverbs they use to describe their thoughts.]
3. [Elicit antonyms for the words you recorded.] ***Tell me a word that means the opposite of*** _____. [Have each student give two responses.]
4. Vocabulary Review: ***Who remembers the word you learned yesterday? Let's look at our pictures to help us remember.*** [Wait for responses.]. ***What does it mean?*** [Wait for responses.] ***And what was the word we learned the day before that? What's a word that means the same thing?***

5. Word of the day: ***We have two new words for today. Our words are 'deciduous' and 'coniferous'. Does anyone know what they mean?*** [See if any of the students already know the answer.] ***Deciduous and coniferous are words we use to describe trees. Let's look at some examples.*** [Show the pictures provided.] ***These are deciduous trees. What do you notice about them?*** [Elicit that they have broad leaves, may bear some kind of fruit, change colours, and lose their leaves.] ***These are coniferous trees. What do you notice about them?*** [Elicit that they are evergreen, bear cones, and have needles. Have the students draw an icon for deciduous and coniferous in their picture booklets.]
6. Create a Venn diagram using the loops provided to show the parts that are the same and different about the two types of trees. ***Today we are going to build a Venn diagram. That is a diagram that shows parts of something that are the different, and parts that are the same. In this circle we will put pictures that go with the word 'coniferous.' In this circle we will put things that go with 'deciduous.' And in the middle, we will put things that belong with both.*** [Have the children sort the provided pictures of trees and fall scenes into different plies to go with the terms. Each child will take a turn selecting a picture from the pile and placing it in the diagram. Continue the activity until all the provided pictures are placed. Discuss their choices as they go.]
7. Writing instructions: [Hand out blank pieces of paper and the students' ID stickers.] ***Now it is time to write. Just like yesterday, you will not put your name on your paper - just a sticker. Remember, if you want to fix or change something while you write, don't erase. Just put a line through it, and then write the correction above it. Write a story that goes with this picture.*** [Show the picture from the beginning of the session.] ***Make the story about the people and events in the picture. Remember that a good story has***

beginning, middle, and end. You have 10 minutes to write the best story that you can. Go. [Start timer. If children ask for help with spelling, etc. just encourage them to do their best. When the timer indicates one minute left say:] ***You have one minute to finish your stories.*** [When the timer beeps say:] ***Time is up. If you are part way through a sentence you can finish it, otherwise pencils down.*** [Collect the samples and send the students back to their classrooms.]

Syntax Condition: Session 4

1. Greetings and check-ins
2. Instruction: ***Today we will continue to practice joining sentences, but these adding words will be used to join two whole sentences rather than just two parts of a sentence. We can join sentences like this by using 'and'. For example I could take two sentences like "The dog is big"*** [show the written example] ***and "The dog is mean."*** [Show the written example.] ***Then I can put "and" in the middle.*** [Put the 'and' word card between the two sentences]. ***What do I get?*** [Wait for a volunteer response of "The dog is big and the dog is mean."] . ***Right. That's OK, but here are some other ways I could join them that sound more interesting.*** [Show the printed examples as you say the combined sentences.] ***"The dog is big. Additionally, he is mean." Or I could say, "As well as being big, the dog is mean." Notice how I had to change the words of the first sentence for that one. Another way I could say this is "In addition to being big, the dog is mean."***
3. Student practice: ***OK, now I will get you to try.*** [Give each child two sentence strips. Then, one at a time, have each child join the sentences with "additionally'. If the participant has difficulty generating the combined sentence, arrange the cards and prompt

by saying the first clause (including the conjunction) then have him or her finish. Then give them another two sentences, and have them join those with "In addition to," prompting as necessary. Then finally, give them another two sentences and have them join those with "as well as," again, prompting as necessary. Each student will make one sentence with each of the new conjunctions.]

4. Fun activity: [Play the board game included for today's session. For each turn in the game, have the child pick a conjunction card with either "in addition to" or "as well as" from the pile, and generate a sentence with that conjunction in it. After they make a syntactically correct sentence, they can roll the dice and move their playing piece. Note – the sentence can be semantic nonsense as long as it is correctly formed.] ***Now we are going to play a game. When it is your turn, you will pick a card from the pile and make a sentence with the word on the card. It does not matter if your sentence is silly, but it does have to be correctly formed. After you make your sentence you can take a turn in the game.*** Keep playing the game until the end of the session, making sure that each player has the same number of turns.
5. Writing instructions: [Hand out the story sheets with the sentence starter and the participants' ID stickers.] ***Now it is time to write. Just like yesterday, you will not put your name on your paper - just a sticker. Remember, I don't want you do any erasing. If you want to fix something put a line through it, then write the correction above it. Write your story from the sentence starter I gave you. Today's story starter says, "It was a bright crisp autumn day, so they all headed outdoors to rake the leaves." You have 10 minutes to write the best story that you can. Remember that a good story has beginning, middle, and end. Go.*** [Start the timer. If participants ask for help with

spelling, etc. just encourage them to do their best. When the timer indicates one minute left say:] ***You have one minute to finish your stories.*** [When the timer beeps say:] ***Time is up. If you are part way through a sentence you can finish it, otherwise pencils down.*** [Collect the samples and send the students back to their classrooms.]

Control Condition

1. Greetings and check-in.
2. Writing instructions: [Hand out the story sheets with the sentence starter and the student ID stickers. Say:] ***Now it is time to write. Just like yesterday, you will not put your name on your paper - just your sticker. Remember, I don't want you do any erasing. If you want to fix something put a line through it, then write the correction above it. Write your story from this picture*** [place the picture where all the students can see it] ***and the sentence starter at the top of your paper. Today's story starter says, "It was a bright crisp autumn day, so they all headed outdoors to rake the leaves." You have 10 minutes to write the best story that you can. Remember that a good story has beginning, middle, and end. Go.*** [Start the timer. If participants ask for help with spelling, etc. just encourage them to do their best. When the timer indicates one minute left say:] ***You have one minute to finish your stories.*** [When the timer beeps say:] ***Time is up. If you are part way through a sentence you can finish it, otherwise pencils down.*** [Collect the samples and send the students back to their classrooms.]

APPENDIX G

Procedures for Hand Scoring Cohesion

This appendix includes a copy of the manual used for the hand coding of cohesion in Experiment 2. It outlines the instructions for preparing and coding the writing samples.

Instructions for Preparing Writing Samples

1. Initial Sample proof read:
    a. First watch the video associated with the samples you are reviewing.
    b. Read through the sample once. Check for and correct any:
        i. Spelling errors or inconsistencies.
        ii. T-unit boundaries.
    c. Delete all digits in the sample number except the last four. This should result in a sample number that looks like XXX-X.
    d. Save and rename the sample with the new 4 digit number in a file called Ready for Scoring.
2. Copy all the samples into a new folder labeled Cohesion Scoring.
    a. Arrange the sentences from the story into a sequential numbered list.
    b. Enclose interjections (sound effects, etc.) in square brackets [] and leave them on the same line as the previous T-unit. Disregard these interjections when coding for cohesion.
    c. Re-save the writing in this format.
3. Code for cohesion as per the below scoring rules directly onto the writing sample.
    a. Fill in the totals for each category on the summary chart (Figure G1). After filling in the chart, count the highlights and the number of markers listed in the chart to

make sure all instances of cohesion have been accurately transferred to the summary form.

b. Transfer totals to excel spreadsheet.

Scoring Rules

Ties in adjacent T-units are coded with the number 1 in the Immediate column on the cohesion chart. Mediated and remote ties are coded by the number of T-units between the item and its referent. Ambiguous ties are coded with a number 1 in the Ambiguous column. See Figure G2 shows a chart with examples and explanations of cohesion types for each scoring category. Below are additional rules to clarify the scoring procedure.

Reference

1. In the case of a pronoun that refers to a group (e.g. they, them, their), count back to the nearest mention of one member of the group ***by a noun***.
2. Immediate pronouns always refer to a noun ***in the previous sentence.*** Do not count pronouns that refer to someone/something mentioned within the same sentence.
3. Always count back to the nearest noun. For the purposes of reference, substitution words like "one" will count as a noun.
4. A pronoun/demonstrative is considered mediated it there is any mention of the character, item or event in the previous sentence (by pronoun). To determine the distance, count back to the nearest noun.
5. If a reference appears after any break in the reference chain, it is considered remote.
6. If a demonstrative appears but the noun is omitted, score as a 0.
7. When 'the' is used exophorically (correctly used to refer to a specific item understood through world knowledge) score the first occurrence as 0. Later use of demonstratives

with that same noun (and the same case) count as a within text demonstrative (e.g. count one character's hiccups as one case, and another character's hiccups as another case).

8. If a pronoun refers to a pronoun in the previous sentence, but that previous pronoun is ambiguous, count back to the last possible noun and code it as remote. If no previous noun exists, or it is unclear to whom or what the pronoun might refer, count it as ambiguous.
9. If a pronoun is repeated, but it is unclear where to count back (as per rule 8), count it as ambiguous.
10. When 'that' is used at the end of a story to refer to the final event as the start of a new story (e.g. "That was that was how his day began." Or "That is another story" count it as a 1 (referring back to the event in the previous sentence). If used in a concluding comment referring back to the whole story (e.g. "That's the whole story.") then code it as a 0 (the referent is implied as the whole story, but not a specific point in the story to which you can count back).
11. When demonstratives and pronouns are used in literary devices (e.g. "<u>There</u> once was a penguin..."or "<u>This</u> story is about...") then count them as a 0s.
12. When 'this time' is used to refer to the event in the previous sentence score it as 1 (e.g. "He tried to blow up the balloon again. This time it worked."). If it refers cataphorically to an event within the same sentence, count it as a 0.

Conjunction

13. Only count coordinate conjunctions that join T-units (those that appear at the beginning of the T-unit), and subordinate conjunctions whether they appear at the beginning or in the middle of T-units.

Lexical

14. To determine the distance of the connection, count back to the **same word**. If a pronoun or substitution term like 'one' that refers to that item is used in the previous sentence consider the item mediated. Otherwise it is immediate or remote.
15. If a phrase is consistently used throughout a story to refer to the same character, item, event, or place (e.g. "little brother Pingo" or the "Fraser River"), count the entire phrase as one instance of lexical repetition.
16. One word may be counted in more than one category of lexical cohesion. That is, it may be counted as both an example of reiteration (repeating word, super/subordinate, or synonym/near synonym) and collocation (complementary or converse terms). One word cannot count as multiple types of reiteration, or as multiple instances of collocation. To determine distance and type, count back to the nearest term.
17. Lexical reiteration involves the use of words **to refer back** to an already mentioned character, item, place, or event. It does not include repetitive use of adjectives, adverbs, and verbs (unless used to refer to an event).
18. If the same word is used to refer to different characters, events, places or items, without further specification (e.g. another, a different, etc.) then count it as ambiguous lexical repetition.
19. Complimentary terms for emotion words will be verbs of action associated with that word, but **not** other emotion words (e.g. angry- shouted will be counted as compliments but angry-happy will not be).
20. For each of the six stories used for the pre-, mid-, and postassessments, a list of common complementary and converse terms will be generated to assist in consistency with

scoring. Only items to which both raters agree will be counted. These items will be recorded in the collocation chart shown in Table G1.

Cohesion Checklist Data form			**Sample #**				**T-Units**			
Type of Cohesion Marker			Immediate		Mediated		Remote		Ambiguous	
REF	Pronouns									
	Totals – counted/distance									
	Demonstratives									
	Totals – counted/distance									
CON –list types and counts	Additive		**and**				**other**			
	Coordinating temporal		**so/then**							
	Subordinating temporal		**when**				**other**			
	Adverbials									
	Causal		**because**				**other**			
	Adversative		**but**				**other**			
LEX	Repetition									
	Totals –counted/distance									
	Super-ordinates or subordinates True synonyms or near-synonyms									
	Totals –counted/distance									
	Complementary terms Converses or antonyms									
	Totals – counted/distance									

Figure G1. Cohesion Summary Form used to record hand scores for each writing sample.

Type of Cohesion Marker		Immediate	Mediated	Remote	Ambiguous
Reference	Pronouns refer back to previously mentioned noun ***he, she, it, they, him, her, them, his, her/s, their/s, its, we, us, our/s, your, yours (this, these, those, that, here, there)***	Referent is in the previous sentence	Noun is not in the previous sentence but a referent in the form of a pronoun is.	There is no referent of any kind in the previous sentence.	There is more than one possible referent in the text.
	Demonstratives that refer back to some previously mentioned noun ***the, that, this, those, these***				
Lexical	***Repeating*** word referring to a character, place, item or event.				
	Super-ordinates or subordinates used to refer to the same character, event, item, or place. (e.g. dog-animal)				
	True synonyms or near-synonyms used to refer to the same character, event, item, or place. (e.g. dog-mutt or dog-beast)				
	Complementary terms words that commonly co-occur (e.g. gun-shot, beach-sand). See chart for specific examples.				
	Converses or antonym words (e.g. ask-answer, up-down). See the chart for examples.				
Conjunct-ion (words used to join clauses)	**Additive**	and, or, also, another, either , neither as well as, additionally, in addition to, etc.			
	Coordinating temporal	then, so			
	Subordinating temporal	when, before, after, while, until, as, etc.			
	Adverbials: Other temporal/ continuative conjunctions or adverbial phrases:	first, next, last, now, finally, suddenly, the following week, still, etc.			
	Causal	***Because, so*** *(used to show cause),* ***consequently, therefore***, etc.			
	Adversative	***But, however, although, yet, instead, except, though, etc.***			

Figure G2. A chart of examples and explanations for the different cohesion categories. This chart was used as a scoring companion during sample coding.

Table G1

Collocation Chart

Story	Complementary terms	Converses/Antonyms
all	family, father, dad, mother, mom, brother, sister, baby, sibling, parents	older/bigger-younger/little (when referring to siblings) inside/in – outside/out (used as nouns)
1	drinking, slurping, juice, straw, cup read, book, comic book penguin, seal (sea lion), walrus happy, laugh mad, angry scared, scream, freak out ice, icicles, snow	
2	***ball*** - bounce, throw, catch ***doorbell***- ring, push, press, button, ding-dong house, wall, door, window, doorbell, home* (*unless used to refer to the "building" in which case count it as a synonym) ***store/shop*** - counter, salesman, manager ***store/shop*** - pay, buy, bought penguin, igloo, snow	broke-fix, repair, replace ring (doorbell)- answered old-new

Table G1 continues

Table G1 continued

Story	Complementary terms	Converses/Antonyms
2	upset/angry/mad - yelled	
	first aid - bandage	
	happy- laugh	
3	crab-pinch, snap, scuttle	lost-find, disappeared-searched
	cage/tank- lid	
	mother-home	
	couch, chair-sat, home/house-table, couch, door	
	pinched- wound, hurt - cry	
	school-teacher-class-students	
	red, yellow, green, blue (in reference to the	
	crabs)	
	penguin-beak	
	pond/puddle-water (when not referring to the	
	specific body of water)	
4	balloon –deflated , inflate, play	problem - solution
	blow – pump, air	inflate - deflate
	house – door, shed, garage	tied - untied
	igloo -snow	sad- happy (for same character)
	sad- cry	blow - suck
		come/came – go ,went

Table G1 continues

Table G1 continued

Story	Complementary terms	Converses/Antonyms
5	cooking, dishes, kitchen	on-off
	jumping, bed, trampoline, bounce (count bounce/ jump back to trampoline but not trampoline back to jump/bounce),	up-down
	(his)room-bed	came-went or left
	room, living room, kitchen, house, couch, chair, floor, door, bed	start-stopped
	chair, cushion, sit, pillow	missing-found
	play, toys	
	build, tool, supplies, work, nailed	
	dishes-shelves	
6	playing, toys, stuffy (stuffing), teddy bear, toy shop, doll, drum	started-stopped
	think, decide, thought, idea	
	snow, snowman/snowmobile (but not snowman to snowmobile)	sad-cheer-up/happy
	riding, scooter, wagon	left-came (same character coming and going)
	truck/car-driveway, pedal	
	sad-crying-upset	

APPENDIX H

An Example of a Coded Writing Sample with Corresponding Coh-Metrix Scores

This appendix contains an example of a coded writing sample from the study. Table H1 provides the coding scheme used for demonstration purposes. (During the hand scoring, we used colours rather than underlines, letters, and italics to code devices.) Italicized words indicate reference ties, underlined words indicate lexical ties, and boxed words indicate conjunction ties. At the end of each T-unit is the code for each corresponding tie. The codes are listed in the order in which the ties appear in the T-unit. The numerals indicate the distance, in T-units, from the original referent. Any number greater than 1 indicates a mediated or remote tie. If the number is preceded by an *R*, it is remote. Lower case letters following the number indicate the specific subtype of cohesion. Conjunctions were not coded for distance as they are always immediate. Additionally, only reference and lexical repetition could be ambiguous. The coded writing sample is presented in Figure H1.

Table H2 shows the tally and distances recorded for the writing sample in Figure H1. This sample contained a total of 16 reference ties, 23 lexical ties, and 11 conjunctions. The total of mediated and remote ties was 20, and the total distance of those combined ties was 61 resulting in a mean distance of 3.05 for this sample.

Additionally, the Coh-Metrix scores generated for this sample are presented in Table H3. Table H3 also shows the mean score and standard deviation for all of the samples written on the same topic and day. As can be seen from the descriptive statistics, the example provided represents a relatively *average* story in terms of Coh-Metrix scores.

1. Pinga's big brother Tom was jumping on his bed.
2. Momma noticed that *he* was. *1p*
3. And *he* got in trouble. *2p*
4. So Momma made Tom sit on the couch. R2r, 3r
5. Then *he* started bouncing on *the* couch. *1p*, R4s, *1d*, 1r
6. Momma got even madder than before and told *him* to stop jumping on *the* couch. R2r, *2p*, 1s, *1d*, 1r
7. Papa came home. 1c
8. And Momma told *him* what Tom was doing. R2r, *1p*, R4r
9. So Papa and Tom got some supplies and started building something. 2r, 1r
10. *They* had tool and stick. *1p*, 1c
11. After some hard work there was a frame for something. 1c
12. Papa got a tarp and put it on. R3r
13. *It* was a trampoline. *R2p*
14. When Momma came home from shopping, she start yelling at Papa for building *that* thing. R8r, R2r, R5r, *1d*
15. So Papa brought *it* outside and started to bounce on it. 1r, *1p*, R2c
16. However *they* still had to clean up. *1p*
17. *Their* momma called *them* in to clean up. *Ap*, R3r, *2p*, 1r
18. And *they* did. *3p*
19. Then *they* bounced some more until they were tired. *4p*, R4r

Figure H1. An example of a coded writing sample.

Table H1

Codes for Reference and Lexical Cohesion

Cohesion	Subtype	Text Mark	Immediate	Mediated	Remote	Ambiguous
Ref	Pro	*italic*	*1p*	*2p*	*R2p*	*Ap*
	Demo	*italic*	*1d*	*2d*	*R2d*	*Ad*
	Repeat	underline	1r	2r	R2r	As
Lex	Synon	underline	1s	2s	R2s	
	Coll	underline	1c	2c	R2c	

Note. Ref = reference; Lex = lexical; Pro = pronoun; Demo = demonstrative; Repeat = repetition; Synon = synonyms and near synonyms; Coll = collocation.

Table H2

Tallies and Distance for Each Type of Tie from the Example.

Cohesive Device			Immediate	Mediated	Remote	Ambiguous
Ref	Pro	Tally	*1, 1, 1, 1, 1, 1*	*2, 2, 2, 3, 4*	*2*	*1*
		No.(Dist)	6	5 (13)	1 (2)	1
	Dem	Tally	*1, 1, 1*			
		No.(Dist)	3			
Lex	Rep	Tally	*1, 1, 1, 1, 1*	*3, 2*	*2, 2, 2, 4, 3, 8, 2, 5, 3, 4*	
		No.(Dist)	5	2 (5)	10 (35)	
	Synon	Tally	*1*		*4*	
		No.(Dist)	1		1 (4)	
	Coll	Tally	*1, 1, 1*		*2*	
		No.(Dist)	3		1 (2)	
Conj	Coord	No.	8			
	Subtemp	No.	2			
	Adverse	No.	1			

Note. Ref = reference ties; Lex = lexical ties; Conj = conjunctions; Pro = pronouns; Dem = demonstratives; Rep = repetition; Synon = synonyms and near synonyms; Coll = collocation; Coord = coordinating additive and temporal conjunctions; Subtemp = subordinating temporal conjunctions; Adverse = adversative conjunctions; No. = number of ties; Dist = distance.

Table H3

Coh-Metrix Scores for the Writing Example and Group Mean Scores.

Coh-Metrix Variable	Sample Score	*M*	*SD*
Anaphor overlap	0.67	0.47	0.20
LSA	0.16	0.18	0.07
Incidence of Connectives	145	147	40